I

Name _____

Roll No. _____ Year 20____20____

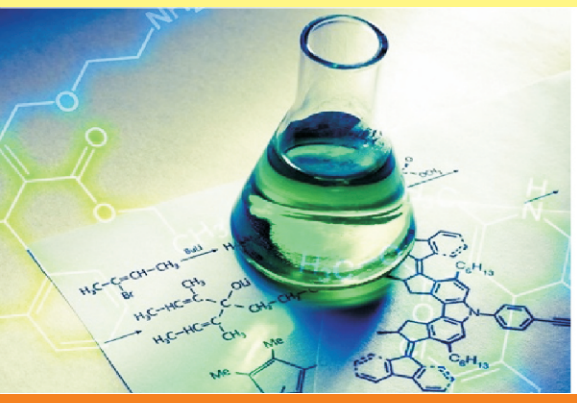
Exam Seat No. _____

CHEMICAL GROUP | SEMESTER - IV | DIPLOMA IN ENGINEERING AND TECHNOLOGY

A LABORATORY MANUAL

FOR

TECHNOLOGY OF ORGANIC CHEMICALS (22410)



MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION, MUMBAI

(Autonomous) (ISO 9001 : 2015) (ISO / IEC 27001 : 2013)

VISION

To ensure that the Diploma level Technical Education constantly matches the latest requirements of technology and industry and includes the all-round personal development of students including social concerns and to become globally competitive, technology led organization.

MISSION

To provide high quality technical and managerial manpower, information and consultancy services to the industry and community to enable the industry and community to face the changing technological and environmental challenges.

QUALITY POLICY

We, at MSBTE are committed to offer the best in class academic services to the students and institutes to enhance the delight of industry and society. This will be achieved through continual improvement in management practices adopted in the process of curriculum design, development, implementation, evaluation and monitoring system along with adequate faculty development programmes.

CORE VALUES

MSBTE believes in the followings:

- Education industry produces live products.
- Market requirements do not wait for curriculum changes.
- Question paper is the reflector of academic standards of educational organization.
- Well designed curriculum needs effective implementation too.
- Competency based curriculum is the backbone of need based program.
- Technical skills do need support of life skills.
- Best teachers are the national assets.
- Effective teaching learning process is impossible without learning resources.

A Laboratory Manual
for

Technology of Organic Chemicals

(22410)

Semester – IV

(CH)

Maharashtra State
Board of Technical Education, Mumbai
(Autonomous) (ISO 9001:2015) (ISO/IEC 27001:2013)

Maharashtra State Board of Technical Education,
(Autonomous) (ISO 9001 : 2015) (ISO/IEC 27001 : 2013)
4th Floor, Government Polytechnic Building, 49, Kherwadi,
Bandra (East), Mumbai - 400051.
(Printed on November 2018)

Maharashtra State
Board of Technical Education

Certificate

This is to certify that Mr. / Ms. …… Roll No…….. of Fourth Semester of Diploma in Chemical Engineering of Institute …… …….. (Code……..) has completed the term work satisfactorily in course **Technology of Organic Chemicals (22410)** for the academic year 20…….to 20…..... as prescribed in the curriculum.

Place ……. Enrollment No……
Date:…..... Exam Seat No. ……..

Course Teacher **Head of the Department** **Principal**

Seal of the Institute

Preface

The primary focus of any engineering laboratory/ field work in the technical education system is to develop the much needed industry relevant competencies and skills. With this in view, MSBTE embarked on this innovative 'I' Scheme curricula for engineering diploma programmes with outcome-base education as the focus and accordingly, relatively large amount of time is allotted for the practical work. This displays the great importance of laboratory work making each teacher; instructor and student to realize that every minute of the laboratory time need to be effectively utilized to develop these outcomes, rather than doing other mundane activities. Therefore, for the successful implementation of this outcome-based curriculum, every practical has been designed to serve as a ***'vehicle'*** to develop this industry identified competency in every student. The practical skills are difficult to develop through 'chalk and duster' activity in the classroom situation. Accordingly, the 'I' scheme laboratory manual development team designed the practical's to ***focus*** on the ***outcomes***, rather than the traditional age old practice of conducting practical's to 'verify the theory' (which may become a byproduct along the way).

This laboratory manual is designed to help all stakeholders, especially the students, teachers and instructors to develop in the student the pre-determined outcomes. It is expected from each student that at least a day in advance, they have to thoroughly read through the concerned practical procedure that they will do the next day and understand the minimum theoretical background associated with the practical. Every practical in this manual begins by identifying the competency, industry relevant skills, course outcomes and practical outcomes which serve as a key focal point for doing the practical. The students will then become aware about the skills they will achieve through procedure shown there and necessary precautions to be taken, which will help them to apply in solving real-world problems in their professional life.

This manual also provides guidelines to teachers and instructors to effectively facilitate student-centered lab activities through each practical exercise by arranging and managing necessary resources in order that the students follow the procedures and precautions systematically ensuring the achievement of outcomes in the students.

During their practicals in the course Technology of Organic Chemicals students will learn to handle and use of various organic chemicals used in the industry. Different types of chemicals ranging from edible oil, phenol, alcohol, paint, paper, polymers are handled in the chemical industry either as raw material or products. Their testing using various instruments and apparatus is necessary for insuring quality. Students will also learn various test procedures, handling and operation of various apparatus during practicals. Interpretation of results and necessary action based on it will enhance industrial applications of practicals.

Although all care has been taken to check for mistakes in this laboratory manual, yet it is impossible to claim perfection especially as this is the first edition. Any such errors and suggestions for improvement can be brought to our notice and are highly welcome.

Programme Outcomes (POs) to be achieved through Practical of this Course:-

Following POs and PSO are expected to be achieved through the practical's of Technology of Organic Chemicals.

PO1. **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical **Engineering** problems

PO2. **Discipline knowledge:** Apply **Chemical Engineering** knowledge to solve industry based Chemical Engineering problems.

PO3. **Experiments and practice :** Plan to perform experiments and practices to use the results to solve technical problems related to **Chemical Engineering**.

PO4. **Engineering tools:** Apply relevant technologies and **Chemical Engineering** tools with an understanding of the limitations.

PSO2. **Material management and quality control:** manage chemicals and equipment to produce quality chemical products.

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List of Industry Relevant Skills

The following industry relevant skills of the competency 'Qualitative & analytical skills.' are expected to be developed in you by undertaking the practical's of this practical manual.

1. Follow the various safety norms and use of PPE.
2. Handle various chemicals safely
3. Prepare setups for various analyses.
4. Operate various lab equipment.

Practical - Course Outcome matrix

Course Outcomes (COs)

a. Use fermentation process for manufacturing of alcohol and its products.
b. Prepare the soap and detergent using relevant oils.
c. Use hiding power principle for manufacturing of paint varnishes and lacquers.
d. Use polymerization process for preparation of various polymers.
e. Prepare phenol using per-oxidation process.
f. Prepare pulp and paper using sulphate and sulphite processes.

S. No.	Practical Outcome	CO a.	CO b.	CO c.	CO d.	CO e.	CO f.
1.	Estimate the strength of glacial acetic acid by titration.	√	-	-	-	-	-
2.	Prepare ethyl acetate from ethanol and acetic acid	√	-	-	-	-	-
3.	Determine viscosity of ground nut oil using redwood viscometer.	-	√	-	-	-	-
4.	Determine viscosity of castor oil using redwood viscometer	-	√	-	-	-	-
5.	Determine viscosity of soya bean oil using redwood viscometer	-	√	-	-	-	-
6.	Determine iodine value of oil by titration method.	-	√	-	-	-	-
7.	Determine saponification value of lubricating oil by KOH titration method.	-	√	-	-	-	-
8.	Determine acid value of lubricating oil by KOH method	-	√	-	-	-	-
9.	Prepare soap by batch saponification process	-	√	-	-	-	-
10.	Determine moisture content in soap	-	√	-	-	-	-
11.	Determine hiding power of given sample of paint	-	-	√	-	-	-
12.	Determine the percentage of thinner in given sample of oil paint	-	-	√	-	-	-
13.	Prepare phenol formaldehyde resin on laboratory scale	-	-	-	√	-	-
14.	Determine acid value of given sample of polymer	-	-	-	√	-	-
15.	Determine acid value of given sample of phenol	-	-	-		√	-
16.	Perform decolorization of paper by bleaching	-	-	-			√

Guidelines to Teachers

1. ***Teacher need to ensure that a dated log book*** for the whole semester, apart from the laboratory manual is maintained by every student which s/he has to ***submit for assessment to the teacher*** in the next practical session.
2. There will be two sheets of blank pages after every practical for the student to report other matters (if any), which is not mentioned in the printed practical's.
3. For difficult practical's if required, teacher could provide the demonstration of the practical emphasizing of the skills which the student should achieve.
4. Teachers should give opportunity to students for hands-on after the demonstration.
5. Assess the skill achievement of the students and COs of each unit.
6. One or two questions ought to be added in each practical for different batches. For this teachers can maintain various practical related question bank for each course.
7. If some repetitive information like data sheet, use of software tools etc. has to be provided for effective attainment of practical outcomes, they can be incorporated in Appendix.
8. For effective implementation and attainment of practical outcomes, teacher ought to ensure that in the beginning itself of each practical, students must read through the complete write-up of that practical sheet.
9. During practical, ensure that each student gets chance and takes active part in taking observations/ readings and performing practical.
10. Teacher ought to assess the performance of students continuously according to the MSBTE guidelines

Instructions for Students

1. For incidental writing on the day of each practical session every student should maintain a ***dated log book*** for the whole semester, apart from this laboratory manual which s/he has to ***submit for assessment to the teacher*** in the next practical session.
2. For effective implementation and attainment of practical outcomes, in the beginning itself of each practical, students need to read through the complete write-up including the practical related questions and assessment scheme of that practical sheet.
3. Student ought to refer the data books, IS codes, Safety norms, Electricity act/rules, technical manuals, etc.
4. Student should not hesitate to ask any difficulties they face during the conduct of practical's.

Content Page

List of Practical's and Progressive Assessment Sheet

Note: To be transferred to Proforma of CIAAN-2017.

Practical No. 1: Estimate strength of glacial acetic acid by titration

I. Practical Significance

Strength of an acid is a measure of the degree of its ionization. Strong acids are fully ionized but weak acids are only partially ionized. Weak acids do not dissociate fully.

II. Relevant Program Outcomes (POs)

PO 1. Basic knowledge: Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 2. **Discipline knowledge**: Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.
PO 3. **Experiments and practice**: Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III. Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency ***'Apply the concept of organic chemistry in chemical engineering applications.***'

1. Perform acid base titration to determine acid strength.
2. Follow safety precaution while handling hazardous chemicals.

IV. Relevant Course Outcomes

Use fermentation process for manufacturing of alcohol and its products

V. Practical Outcome

Determine the strength of acetic acid by chemical method.

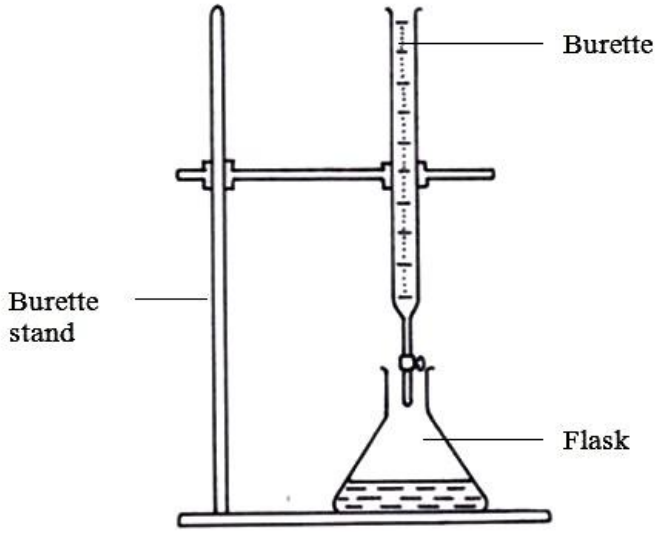
VI. Relevant Affective domain related Outcomes

1. Follow safe practices.
2. Practice good housekeeping.

VII. Minimum Theoretical Background

Acetic acid (CH_3COOH), also called ethanoic acid, is the most important of the carboxylic acids. A dilute (approximately 5 percent by volume) solution of acetic acid produced by fermentation and oxidation of natural carbohydrates is called vinegar; a salt, ester, or acylal of acetic acid is called acetate. Industrially, acetic acid is used in the preparation of metal acetates, used in some printing processes. Vinyl acetates is employed in the production of plastics, cellulose acetate is used in making photographic films and textiles and volatile organic esters (such as ethyl and butyl acetates)are widely used as solvents for resins, paints, and lacquers. Biologically, acetic acid is an important metabolic intermediate, and it occurs naturally in body fluids and in plant juices. Pure acetic acid, often called glacial acetic acid, is a corrosive, colourless liquid (boiling point 117.9 °C [244.2 °F]; melting point 16.6 °C [61.9 °F]) that is completely miscible with water. Acetic acid has been prepared on an industrial scale by air oxidation of acetaldehyde, by oxidation of ethanol and by oxidation of butane and butene.

VIII. Practical set up



IX. Resources required

S. No.	Instrument /Components	Specification	Quantity
1.	Beaker	100ml	1 No.
2.	Volumetric flask	250ml	1 No.
3.	Pipette	10ml	1No.
4.	Burette	25ml	1No.
5.	Conical flask	250ml	1No.

X. Precautions to be followed

1 Use apron while doing practical

2 Use hand gloves while handling concentrate chemicals.

XI. Procedure

1. Take accurate 10 ml of the given sample of acetic acid through a pipette into standard flask.
2. Add distilled water to make up the solution to 250 ml
3. Pipette out 10 ml of the prepared diluted solution from volumetric flask into the conical flask.
4. Add 2-3 drops of phenolphthalein indicator to the conical flask.
5. Fill the burette with 0.1 N NaOH solution.
6. Titrate the solution in the conical flask against 0.1 N NaOH solution from the burette till solution turns pink.
7. Repeat step numbers 4 to 8 for getting constant burette reading

XII. Resources used (with major specifications)

Sr. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XIII. Actual procedure followed

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XIV. Precautions followed

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XV. Observations and calculations

In burette : 0.1N NaOH solution
In conical flask : Diluted acetic acid solution (10 ml)
End point : colorless to pink
Indicator used : Phenolphthalein.

Burette Reading

Reading	Burette reading in ml			Constant burette reading in ml
	I	II	III	
Initial				
Final				
Difference				

Normality of diluted Acetic acid (Sample acid) by titration , Let,

N_1 = Normality of diluted acetic acid sample.

V_1= Volume of diluted acetic acid sample (10 ml).

N_2= Normality of NaOH solution taken = 0.1 N (taken)

V_2=Volume of 0.1N NaOH solution (from titration)

$N_1 = V_2 N_2 / V_1$ =

Actual amount of acetic acid present in 250 ml of diluted acid solution, W_1 grams

$$W_1 \text{ (Strength)} = \frac{N_1 \times 250 \times \text{equivalent weight of acetic acid}}{1000}$$

XVI. Results

The strength of acetic acid is = ----------

XVII. Interpretation of results

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XVIII. Conclusions

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XIX. Practical related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Name the two weak bases and two weak acids
2. Name the two strong bases and two strong acids.
3. Write the type of reaction occurring in this experiment.
4. What is the neutralization point in this experiment?
5. Give the uses of acetic acid.

[Space for Answers]

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XX. References / Suggestions for further Reading

1. www.creatingtechnology.org
2. www.thechemicalengineer.com
3. www.chemistry.harvard.edu

XXI. Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of the chemicals and apparatus.	20%
2	Recording of readings	20%
3	Determination of strength	20%
Product related (10 Marks)		**40%**
4	Interpretation of result & conclusions	20%
5	Practical related questions	20%
Total (25 Marks)		100 %

Names of Student Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			**Dated signature of Teacher**
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 2: Prepare ethyl acetate from ethanol and acetic acid

I. Practical Significance

Ethyl acetate is synthesized via the Fischer esterification reaction from ethanol and acetic acid, typically in the presence of an acid catalyst such as concentrated sulfuric acid. Fischer esterification is a special type of esterification by refluxing a carboxylic acid and an alcohol in the presence of an acid catalyst. The reaction was first described by Emil Fischer and Arthur Speier in 1895.

II. Relevant Program Outcomes (POs)

PO 1. **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III. Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency ***'Apply the concept of organic chemistry in chemical engineering applications.***'

1. Apply basic concept of organic chemistry in chemical engineering applications.
2. Follow safety precaution while handling hazardous chemicals.

IV. Relevant Course Outcomes

Use fermentation process for manufacturing of alcohol and its products

V. Practical Outcome

Prepare Ethyl Acetate from ethanol and acetic acid

VI. Relevant Affective domain related Outcomes

1. Follow safe practices.
2. Practice good housekeeping.

VII. Minimum Theoretical Background

Ethyl acetate is the organic compound with the formula $CH_3COOC_2H_5$ and having a molecular weight of 88.10. This colourless liquid has a characteristic, pungent smell like certain glues or nail polish removers, in which it is used. Ethyl acetate is the ester from ethanol and acetic acid; it is manufactured on a large scale for use as a solvent. Ethyl acetate is a moderately polar solvent that has the advantages of being volatile, relatively non-toxic, and non-hygroscopic. It is a weak hydrogen bond acceptor, and is not a donor due to the lack of an acidic proton. Ethyl acetate can dissolve up to 3% water and has a solubility of 8% in water at room temperature. It

is unstable in the presence of strong aqueous bases and acids. It is soluble in most organic solvents, such as alcohol, acetone, ether and chloroform. It has been also used as solvent in many chemical processes

VIII. Experimental set up

Figure. 1 Reflux apparatus for esterification

IX. Resources required

S. No.	Apparatus	Specification	Quantity
1	Reflux apparatus for esterification	500 ml	1
2	Separating funnel		1
3	beaker	250 ml	2
4	Measuring cylinder	50ml	1

X. Precautions to be followed

1. Use apron while doing practical
2. Use hand gloves while handling concentrated chemicals.

XI. Procedure

1. Set up a reflux apparatus as shown in figure using a clean and dry condenser and an appropriate sized round –bottomed flask.
2. Measure 40 ml of 95 % of ethanol and add it to the round- bottomed flask.
3. Measure out 30 ml of glacial acetic acid, and add it to the round –bottomed flask already containing alcohol.
4. Add several boiling stones to the round –bottomed flask containing the alcohol and carboxylic acid.
5. Very slowly and carefully add 5ml of concentrated sulphuric acid, while swirling and cooling the flask.
6. Quickly reassemble the reflux apparatus, and heat the reaction for 45 min to 01 hour, while maintaining a steady reflux.

7. Remove the heating mantle and cool the reaction mixture to room temperature. You may speed the cooling up by placing the stoppered round – bottomed flask into a lukewarm water bath. Do not use an ice bath.
8. Pour the cooled mixture into a small separating funnel containing 20 ml of water ice. Rinse the round –bottomed flask with a further 5 ml of cold distilled water, and add this also to the separating funnel .Stopper the separating funnel and invert it several times.
9. Extract your ester with 25 ml of diethyl ether and separate the layers .Keep the aqueous layer. Do not discard anything yet.
10. Wash the crude ester (in the diethyl ether) with 25 ml cold distilled water [the purpose of this step is to wash away the water soluble impurities].
11. Wash the crude ester (in diethyl ether) with 25ml of 5% M sodium carbonate. Be extra careful to frequently vent the separating funnel, as you gently swirl the contents of the funnel. Do not invert the funnel at first. Carbon dioxide gas is formed during this step, and significant pressure builds up inside the funnel. When the amount of gas has declined, then invert and periodically vent the funnel.
12. Repeat the wash of the crude ester with another 25ml of 5 % sodium carbonate. Less CO_2 gas should be produced in this step than the previous.
13. Check the pH of the solution. It should be close to pH = 7.0.
14. Wash the crude ester with 25 ml of saturated sodium chloride. Withdraw the aqueous salt solution out the bottom of the funnel and pour the ester out the top of the separating funnel into a small clean , dry Erlenmeyer flask.
15. Dry the crude ester with anhydrous calcium chloride. Stopper and swirl the flask periodically for 15 min. be sure to add enough of the anhydrous drying agent so that some of it is still freely moving in the liquid. When the ester is dry, the crude ester should be clear and transparent; cloudiness indicates that water is still present.
16. Decant the dry ester and if time permits, set up an apparatus for a simple distillation.
17. Distill the crude ester, and collect the product in an appropriate sized, pre-weighed, clean, dry round bottom flask.

XII. Resources used (with major specifications)

S. No.	Instrument /Components	Specification	Quantity
1			
2			
3			
4			
5			

XIII. Actual procedure followed

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XIV. Precautions followed

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XV. Observations and Calculations:

	Molar mass	Density(g/ml)	Mole equivalent	Moles used	Mass used (gm)	Volume used (ml)
Carboxylic acid						
Alcohol						
Ester						

XVI. Results

The weight of ester formed is = ----------

XVII. Interpretation of results

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XVIII. Conclusions

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XIX. Practical related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Give the use of acid in esterification.
2. Write the characteristics of ester.
3. Give the need to add boiling chips in esterification.
4. Observe the reaction without addition of conc. H_2SO_4.
5. Observe the reaction with double the proportion of raw materials and write down the symptoms.

[Space for Answers]

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XX. References / Suggestions for further Reading

1 https://www.ukessays.com/essays/.../introduction-to-ethyl-acetate-biology-essay.php
2 https://www.solventis.net/products/esters/ethyl-acetate/

XXI. Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1.	Handling of the chemicals and apparatus.	20%
2.	Recording of readings	20%
3.	Determination of strength	20%
Product related (10 Marks)		**40%**
4.	Interpretation of result & conclusions	20%
5.	Answers to practical related questions	20%
T**otal (25 Marks)**		**100 %**

Names of Student Team Members

1……

2……

3……

4……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.3: Determine viscosity of groundnut oil using Redwood viscometer.

I. Practical Significance

Fluid viscosity is a basic physical property that directly influences unit operations such as pumping, filtration, distillation, extraction, and evaporation as well as heat and mass transfer. As Temperature effects are highly significant, it is important to determine effect of temperature on viscosity.

II. Relevant Program Outcomes (POs)

PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.
PO 4. **Engineering tools:** Apply relevant technologies and Chemical engineering tools with an understanding of the limitations.

III. Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency ***'Apply the concept of organic chemistry in chemical engineering applications.***'

1. Operate redwood viscometer.
2. Study the effect of temperature on viscosity of oil.

IV. Relevant Course Outcomes

Prepare the soap and detergent using relevant oil

V. Practical Outcome

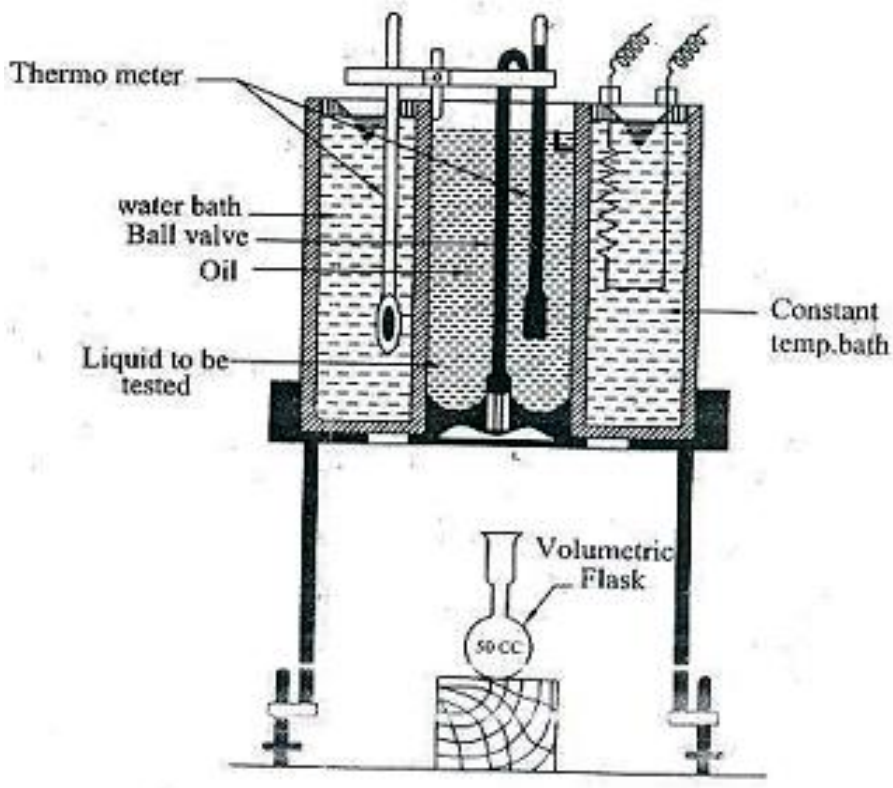
Determine viscosity of groundnut oil using Redwood viscometer

VI. Relevant Affective domain related Outcome

1) Follow safe practices
2) Practice energy conservation

VII. Minimum Theoretical Background

Viscosity is one of the most important property of oil, The formation of a fluid film of a lubricant between the friction surfaces and the generation of frictional heat under particular conditions of load bearing speed and lubricant supply mostly depend upon the viscosity of the lubricant and to some extent on its oiliness. It has been well established that temperature has a strong influence on the viscosity of oil. Hence it is essential to have knowledge of the viscosity.



VIII. Experimental set up

Figure. 1 Redwood viscometer

IX. Resources required

S. No.	Instrumentation/components	Specification	Quantity
1	Beaker	500ml	02
2	Conical flask	100ml	01
3	Thermometer	0 - 120 ^{0}c	01
4	Redwood viscometer	With Kohlrausch flask of 50 ml capacity	01

X. Precautions

1. Care should be taken not to fill the liquid above the pointer level in the oil cup
2. Filter the oil through a100 mesh wire sieve before testing its viscosity.
3. Receiving flask should be placed in such a way that the oil jet touches inside layer of the flask and does not cause foaming.
4. After each reading the oil should be completely drained out of receiving flask.

XI. Procedure

1. Select the appropriate viscometer.
2. Clean the viscometer cup properly with the help of suitable solvent e.g. CCl_4,ether, benzene or petroleum spirit and properly dry to remove any trace of the solvent.
3. Level the viscometer with the help of leveling screws on the tripod.
4. Fill the outer bath with water for determining the viscosity at 80^{o}C and below.
5. Place the ball valve on the jet to close it.
6. Pour the test oil into the cup up to the tip of indicator.
7. Place a clean dry 50 ml flask immediately below and directly in line with discharging jet.
8. Insert a clean thermometer and a stirrer in the cup and cover it with a lid.
9. Heat the water filled in the bath slowly with constant stirring. When the oil in the cup attains a desired temperature stop the heating.
10. Lift the ball valve and start the stop watch, oil from the jet flows into the flask.
11. Stop the stop watch when lower meniscus of the oil reaches the 50 ml mark on the neckof receiving flask.
12. Record the time taken for 50 ml of the oil to collect in the flask.
13. Repeat the experiment at five elevated temperature say 40^{o}C, 50^{o}C, 60^{o}C, 70^{o}C and note the respective times.

XII. Resources used (with major specifications)

Sr. No.	Instrument /Components	Specification	Quantity

XIII Actual procedure followed

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XI Precautions followed

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XV. Observations and Calculations:

Sr.No.	Temperature in ^{o}C	Viscosity, t (Redwood seconds)
1		
2		
3		
4		
5		

Calculations for set no ----

t (Redwood Second) =

Kinematic Viscosity (ν) $= 0.002\,t - \frac{1.8}{t} =$

Density of groundnut oil sample (ρ) =

$\mu = \nu * \rho =$

Temperature=

Viscosity of groundnut oil at----------^{o}C =

XVI Results

Viscosity of the given oil at -------^{o}C = _____

XVII. Interpretation of results

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XVIII. Conclusion

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XIX. Practical related Questions

Note-Below given are five sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO

1. How does the viscosity of liquid vary with temperature?
2. What is viscosity? Define Absolute viscosity.
3. What is the Capacity of the collecting flask?
4. Which solvents are used for cleaning the cup?
5. Give the units of viscosity (any three)

[Space for Answers]

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XX References / Suggestions for further Reading

1. https://www.mechanicalduniya.com/2012/07/redwoodviscometer.html
2. http://nptel.ac.in/courses/101103004/module7/lec1/1.html
3. https://www.youtube.com/watch?v=VzJ60uMdFe8

XXI Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of Apparatus	20%
2	Observation of correct reading	20%
3	Determination of viscosity	20%
Product related (10 Marks)		**40%**
4	Interpretation of result & conclusions	20%
5	Answers to practical related questions	20%
T**otal (25 Marks)**		**100 %**

Names of Student Team Members

1 ……

2 ……

3 ……

4 ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 04: Determine viscosity of castor oil using Redwood viscometer

I . Practical Significance

Fluid viscosity is a basic physical property that directly influences unit operations such as pumping, filtration, distillation, extraction, and evaporation as well as heat and mass transfer. As temperature effects are highly significant, it is important to determine effect of temperature on viscosity.

It has been well established that temperature has a strong influence on the viscosity o fluids with viscosity generally decreasing with increase in temperature.

II. Relevant Program Outcomes (POs)

PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.

PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

PO 4. **Engineering tools:** Apply relevant technologies and Chemical engineering tools with an understanding of the limitations.

III. Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency ***'Apply the concept of organic chemistry in chemical engineering applications.***'

1. Operate redwood viscometer
2. Study the effect of temperature on viscosity of oil.

IV. Relevant Course Outcomes

Prepare the soap and detergent using relevant oils

V. Practical Outcome

Determine viscosity of castor oil using Redwood viscometer

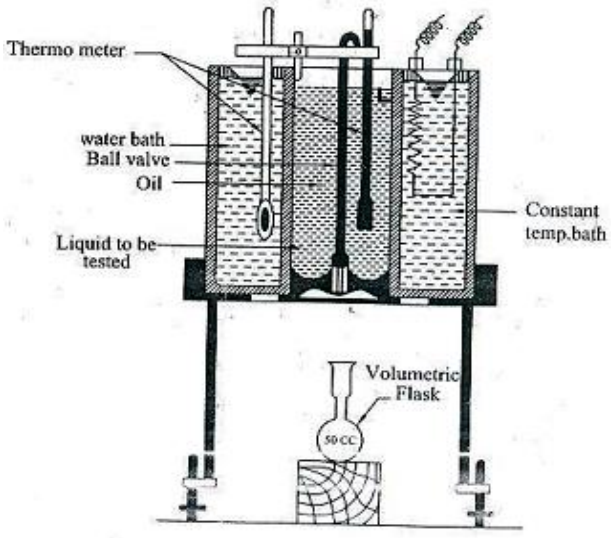
VI. Relevant Affective domain unrelated Outcome(s)

1. Follow safe practices
2. Practice energy conservation

VII. Minimum Theoretical Background

Viscosity is one of the most important property of oil, The formation of a fluid film of a lubricant between the friction surfaces and the generation of frictional heat under particular conditions of load bearing speed and lubricant supply mostly depend upon the viscosity of the lubricant and to some extent on its oiliness.

It has been well established that temperature has a strong influence on the viscosity of oil. Hence it is essential to have knowledge of the viscosity and the effect of temperature on it.



VIII. Experimental set up

Figure 1: Red wood viscometer

IX . Resources required

S. No.	Instrumentation/components	Specification	Quantity
1.	Beaker	500ml	02
2.	Conical flask	100ml	01
3.	Thermometer	0 -100 ^{0}c	01
4.	Redwood viscometer	With 50 ml Kohlrausch flask	01

X. Precautions

1 Care should be taken not to fill the liquid above the pointer level in the oil cup.
2. Filter the oil through a100 mesh wire sieve before testing its viscosity.
3. Receiving flask should be placed in such a way that the oil jet touches inside layer of the flask and does not cause foaming.
4. After each reading the oil should be completely drained out of receiving flask.

XI . Procedure

1 Select the appropriate viscometer.
2. Clean the viscometer cup properly with the help of suitable solvent e.g. CCl_4, ether, benzene or petroleum spirit and properly dry to remove any trace of the solvent.
3. Level the viscometer with the help of leveling screws on the tripod.
4. Fill the outer bath with water for determining the viscosity at 80^oC and below.
5. Place the ball valve on the jet to close it.
6. Pour the test oil into the cup up to the tip of indicator.
7. Place a clean dry 50 ml flask immediately below and directly in line with discharging jet.
7. Insert a clean thermometer and a stirrer in the cup and cover it with a lid.
8. Heat the water filled in the bath slowly with constant stirring. When the oil in the cup attains a desired temperature stop the heating.
9. Lift the ball valve and start the stop watch, oil from the jet flows into the flask.
10. Stop the stop watch when lower meniscus of the oil reaches the 50 ml mark on the neck of receiving flask.
11. Record the time taken for 50 ml of the oil to collect in the flask.
12. Repeat the experiment at five elevated temperature say 40^oC, 50^oC, 60^oC, 70^oC and note the respective times.

XII . Resources used (with major specifications)

Sr. No.	Instrument /Components	Specification	Quantity
1			
2			
3			
4			
5			

XIII. Actual procedure followed

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XIV. Precautions followed

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XV. Observations and Calculations:

S. No.	Temperature in ^{O}C	Viscosity, t (Redwood seconds)
1		
2		
3		
4		
5		

Calculations for set no ----

t (Redwood Second) =

Kinematic Viscosity (ν) = $0.002\,t - \frac{1.8}{t}$ =

Density of castor oil sample (ρ) =

$\mu = \nu * \rho$ =

Temperature=

Viscosity of castor oil at----------^{o}C=

XVI. Results

Viscosity of the given oil at -------^{o}C is _____

XVII. Interpretation of results

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XVIII. Conclusions

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XIX. Practical related Questions

Note-Below given are five sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO

1 Define kinematic viscosity.
2 What is viscosity?
3 Give the value of viscosity of water in $N.S/m^2$.
4 Give the significance of viscosity of liquid in pumping operation
5 Write the material of construction of the oil cup.

[Space for Answers]

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XX. References / Suggestions for further Reading

1. https://www.mechanicalduniya.com/2012/07/redwoodviscometer.html
2. http://nptel.ac.in/courses/101103004/module7/lec1/1.html
3. https://www.youtube.com/watch?v=VzJ60uMdFe8

XXI. Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of Apparatus	20%
2	Observation of correct reading	20%
3	Determination of viscosity	20%
Product related (10 Marks)		**40%**
4	Interpretation of result & conclusions	20%
5	Answers to practical related questions	20%
T**otal (25 Marks)**		**100 %**

Names of Student Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 5: Determine viscosity of Soybean oil using Redwood Viscometer

I. Practical Significance

Fluid viscosity is a basic physical property that directly influences unit operations such as pumping, filtration, distillation, extraction, and evaporation as well as heat and mass transfer. As temperature effects are highly significant, it is important to determine effect of temperature on viscosity.

II. Relevant Program Outcomes (POs)

PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.
PO 4. **Engineering tools:** Apply relevant technologies and Chemical engineering tools with an understanding of the limitations.

III. Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency ***'Apply the concept of organic chemistry in chemical engineering applications.***'

1. Operate redwood viscometer.
2. Study the effect of temperature on viscosity of oil.

IV. Relevant Course Outcomes -

Prepare the soap and detergent using relevant oils

V. Practical Outcome

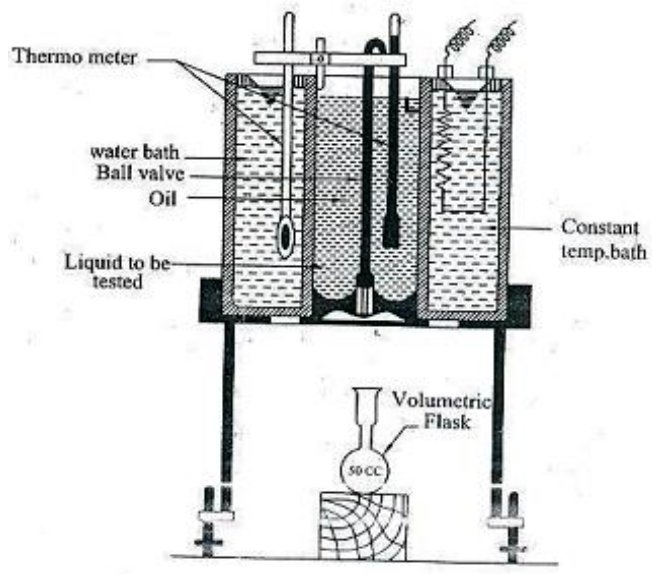
Determine viscosity of Soyabean oil using Redwood viscometer

VI. Relevant Affective domain unrelated Outcome(s)

1. Follow safe practices
2. Practice energy conservation

VII. Minimum Theoretical Background

Viscosity is one of the most important property of oil, The formation of a fluid film of a lubricant between the friction surfaces and the generation of frictional heat under particular conditions of load bearing speed and lubricant supply mostly depend upon the viscosity of the lubricant and to some extent on its oiliness It has been well established that temperature has a strong influence on the viscosity of oil. Hence it is essential to have knowledge of the viscosity and the effect of temperature on it.



VIII. Experimental set up used in laboratory

Figure 1: Red wood viscometer

IX. Resources required

Sr. No.	Instrumentation/components	Specification	Quantity
1	Beaker	500ml	02
2	Conical flask	100ml	01
3	Thermometer	0-100 ^{0}c	01
4	Redwood viscometer	With Kohlrausch flask of 50 ml capacity	01

X. Precautions

1 Care should be taken not to fill the liquid above the pointer level in the oil cup
2. Filter the oil through a100 mesh wire sieve before testing its viscosity.
3. Receiving flask should be placed in such a way that the oil jet touches inside layer of the flask and does not cause foaming.
4. After each reading the oil should be completely drained out of receiving flask.

XI. Procedure

1 Select the appropriate viscometer.
2. Clean the viscometer cup properly with the help of suitable solvent e.g. CCl_4,ether,benzene or petroleum spirit and properly dry to remove any trace of the solvent.
3. Level the viscometer with the help of leveling screws on the tripod.
4. Fill the outer bath with water for determining the viscosity at 80^oC and below.
5. Place the ball valve on the jet to close it.
6. Pour the test oil into the cup up to the tip of indicator.
7. Place a clean dry 50 ml flask immediately below and directly in line with discharging jet.
8. Insert a clean thermometer and a stirrer in the cup and cover it with a lid.
9. Heat the water filled in the bath slowly with constant stirring. When the oil in the cup attains a desired temperature stop the heating.
10. Lift the ball valve and start the stop watch, oil from the jet flows into the flask.
11. Stop the stop watch when lower meniscus of the oil reaches the 50 ml mark on the neck of receiving flask.
12. Record the time taken for 50 ml of the oil to collect in the flask.
13. Repeat the experiment at five elevated temperature say 40^oC, 50^oC, 60^oC, 70^oC and note the respective times.

XII. Resources used (with major specifications)

Sr. No.	Instrument /Components	Specification	Quantity
1			
2			
3			
4			
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XIII. Actual procedure followed

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XIV. Precautions followed

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XV. Observations and Calculations

Sr. No.	Temperature in ^{O}C	Viscosity, t (Redwood seconds)
1		
2		
3		
4		
5		

Calculations for set no ----

t (Redwood Second) =

Kinematic Viscosity (ν) = $0.002\,t - \frac{1.8}{t}$ =

Density of soyabean oil sample (ρ) =

$\mu = \nu * \rho$ =

Temperature =

Viscosity of soyabean oil at----------^{o}C=

XVI. Results

Viscosity of the given oil at -------^{o}C is _____

XVII. Interpretation of results

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XVIII. Conclusions

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XIX. Practical related Questions

Below given are five sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO

1 Define viscosity index?
2 Calculate viscosity index for the given oil
3 From the performed practical's identify the most viscous oil.
4 Write down the essential parts of Redwood viscometer
5 Give the use of thermometer in Redwood viscometer

[Space for Answers]

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XX. References / Suggestions for further Reading

1. https://www.mechanicalduniya.com/2012/07/redwoodviscometer.html
2. http://nptel.ac.in/courses/101103004/module7/lec1/1.html
3. https://www.youtube.com/watch?v=VzJ60uMdFe8

XI. Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1.	Handling of Apparatus	20%
2.	Observation of correct reading	20%
3.	Determination of viscosity	20%
Product related (10 Marks)		**40%**
4.	Interpretation of result & conclusions	20%
5.	Answers to practical related questions	20%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.6: Determine Iodine value of oil by titration method

I. Practical Significance

Iodine value intended as a measure of unsaturation and at times it is used as a quick alternative to oxidation test of oil. Iodine value indicates the drying quality of an oil. Iodine value is of real significance in the examination of fatty oils since most fatty oils have their own characteristic iodine values.

II. Relevant Program Outcomes (POs)

PO 1.**Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.

PO 3.**Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

PO 4. **Engineering tools:** Apply relevant technologies and Chemical engineering tools with an understanding of the limitations.

II. Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency ***'Apply the concept of organic chemistry in chemical engineering applications.***'

1. Perform accurate titration.
2. Follow safety precaution while handling hazardous chemicals.

IV. Relevant Course Outcomes

Prepare the soap and detergent using relevant oils

V. Practical Outcome

Determine iodine value of given oil by chemical analysis.

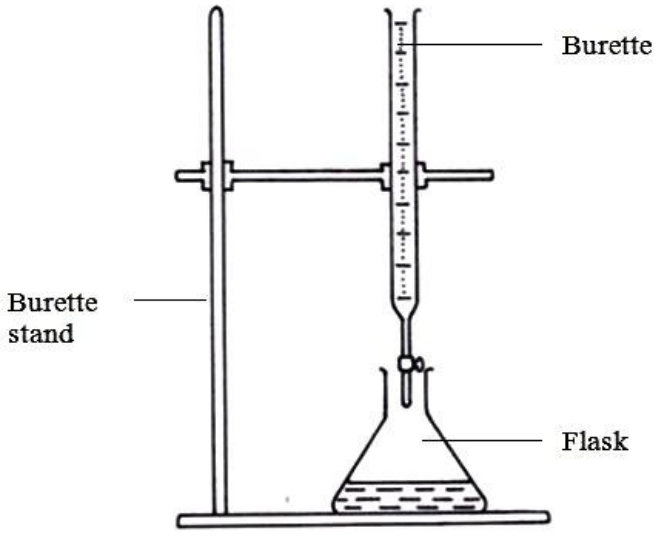
VI. Relevant Affective domain related Outcome

1. Follow safe practices
2. Practice good housekeeping
3. Demonstrate working as leader/ a team member

VII. Minimum Theoretical Background

The iodine value of oil is defined as the amount of iodine grams which reacts with 100 grams of oil. Oils are classified as drying, semi-drying and non drying on the basis of iodine value. Higher the Iodine value, more the unsaturated bonds present in oil or fat. This unsaturation is in the form of double bonds which react with iodine compound. Saturated fatty acids will not give the halogenation reaction. If the iodine number is between 0-70, it will be a fat and if the value exceeds 70, it is an oil. Starch is used as the indicator for this reaction so that the liberated iodine will react with starch to give purple colored product and thus the endpoint can be observed.

VIII. Experimental set up



IX. Resources required

S. No.	Instrumentation/components	Specification	Quantity
1	Beaker	100ml	02
2	Iodination flask	250ml	01
3	Reagent bottle	250ml	01
4	Measuring cylinder	50 ml	01
5	Burette	25ml	01

X. Precautions

1. Use apron while doing practical.
2. Use hand gloves while handling concentrate chemicals.

XI. Procedure

1. Arrange all the reagent solutions prepared and the requirements on the table.
2. Weigh 0.5 grams of oil and dissolve it in chloroform.
3. Pipette out 10 ml of oil sample dissolved in chloroform to an iodination flask labeled as "TEST"
4. Add 20 ml of Iodine monochloride reagent in to the flask.
5. Mix the contents in the flask thoroughly.
6. Then the flask is allowed to stand for half an hour incubation in dark.
7. Set up a BLANK in another iodination flask by adding 10 ml Chloroform to the flask.
8. Add to the BLANK, 20ml of iodine Monochloride reagent and mix the content in the flask thoroughly.

9. Incubate the BLANK in dark for 30 minutes.

10. Meanwhile, take out the TEST from incubation after 30 minutes and add 10ml of potassium iodide solution into the flask.
11. Rinse the stopper and the sides of the flask using 50 ml distilled water.
12. Titrate the TEST against standardized sodium thiosulphate solution until a pale straw colour is observed.
13. Add about 1 ml starch indicator into the contents in the flask, a purple colour is observed.
14. Continue the titration until the colour of the solution in the flask turns colourless.
15. The disappearance of the blue colour is recorded as the end point of the titration.
16. Repeat the procedure to get constant burette reading
17. Similarly the procedure is repeated for the flask labeled BLANK.
18. Record the endpoint values of the BLANK.

XII. Resources used (with major specifications)

Sr. No.	Instrument /Components	Specification	Quantity
1			
2			
3			
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XIII. Actual procedure followed

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XIV. Precautions followed

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XV Observations and Calculations

Observations: (TEST)

1. Weight of oil taken (w) = ……gram
2. Solution in burette = 0.1 N sodium thiosulphate.
3. Solution in iodination flask = oil sample mixed with chloroform + Monochloride regent + potassium iodide.
4. Indicator = 1% starch indicator solution
5. End Point = …….

Sr. No.	Readings Pilot Reading		Burette Reading (ml)			Constant Burette Reading * X_1 (ml)
			I	II	III	
Final						
Initial						
Difference						

Observations: (BLANK)

1. Solution in burette =0.1 N sodium thiosulphate.
2. Solution in iodination flask + = chloroform + Iodine Monochloride regent potassium iodide
3. Indicator = 1% starch indicator solution
4. End Point = …….

Sr. No.	Readings Pilot Reading		Burette Reading (ml)			Constant Burette Reading * X_2 (ml)
			I	II	III	
Final						
Initial						
Difference						

Sample Calculation:

Calculate the iodine number using the equation below:

Volume of Sodium thiosulphate used = [Blank (X_2) – Test (X_1)] ml

=

Iodine No. of oil = (Equivalent Wt. of Iodine * Volume $Na_2S_2O_3$ used * Normality of $Na_2S_2O_3$*100*10^{-3})/ weight of oil sample used for analysis

Equivalent weight of Iodine = 127

Normality of sodium thiosulphate ($Na_2S_2O_3$) = 0.1 N

Iodine no. of oil =

XVI. Results

Iodine value of oil is **……**

XVII. Interpretation of result

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XVIII. Conclusions

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XIX. Practical related Questions

Note-Below given are five sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO

1. Write significance of Iodine value of oil .
2. Name the solvent use for finding the iodine value.
3. Name the oil which is used in the practical.
4. Why starch indicator is used for finding iodine value of oil?
5. Name the oil suitable for making paint considering its iodine value.

[Space for Answers]

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XX. References / Suggestions for further Reading

1. https://www.britannica.com/science/iodine-value
2. https://www.cdrfoodlab.com › Analiysis
3. https://www.classle.net/#!/classle/book/estimation-iodine-value-oil

XXI. Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1.	Handling of the chemicals and apparatus.	20%
2.	Recording of readings	20%
3.	Determination of strength	20%
Product related (10 Marks)		**40%**
4.	Interpretation of result & conclusions	20%
5.	Practical related questions	20%
T**otal (25 Marks)**		100 %

Names of Student Team Members

1……

2……

3……

4……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.07: Determine saponification value of oil (lubricating) by KOH titration method.

I. Practical Significance

Fats and oils are esters of triglycerols of fatty acids. Hydrolysis can break down a fat or oil and release the triglycerols and fatty acids. If the hydrolysis is carried out under alkaline conditions, soap can be made. The reaction is known as saponification. A saponification value can be found for individual fats and oils and it can be used to compare their relative molecular masses. It can also be used to compare the relative chain length of the fatty acids that make up the fat or oil.

II. Relevant Program Outcomes (POs)

Discipline knowledge

1. **PO 1**. **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
2. **PO 3**. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.
3. **PO 4**. **Engineering tools:** Apply relevant technologies and Chemical engineering tools with an understanding of the limitations.

III. Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency ***'Apply the concept of organic chemistry in chemical engineering applications.***'

1. Perform acid base titration to determine base strength.
2. Follow safety precaution while handling hazardous chemicals.

IV. Relevant Course Outcomes

Prepare the soap and detergent using relevant oils

V. Practical Outcome

Determine saponification value of an oil.

VI. Relevant Affective domain related Outcome

1. Follow safe practices
2. Practice energy conservation

VII. Minimum Theoretical Background

The saponification value of the fat or oil is defined as the number of milligrams of potassium hydroxide that react with 1 gram of the oil or fat. The oil or fat should be refluxed with potassium hydroxide. The unreacted potassium hydroxide should then be titrated against hydrochloric acid to determine the amount of unused potassium hydroxide. Therefore, the amount of potassium hydroxide that has reacted with the fat or oil can be determined.

VIII. Experimental set up

Figure 1: Experimental set up

IX. Resources required

Sr. No.	Instrumentation/components	Specification	Quantity
1	Beaker	100ml	02
2	Conical flask	250ml	01
3	Weighing balance	Weight capacity upto 1 Kg	01
4	Measuring cylinder	50 ml	01
5	Burette	25ml	01
6	Pipette	25 ml	01

X. Precautions

1 Use apron while doing practical's

2. Don't touch concentrate chemicals.

XI. Procedure

Part 1

1. Arrange the apparatus as indicated in the diagram.
2. Take 5 gram of oil sample in conical flask.
3. Add 25 ml of the 0.5 N KOH solution into the flask. Place piece of porcelain in conical flask to avoid bumping.

4. Fit the reflux condenser with rubber tubes for inlet and outlet of water with conical flask using the single hole rubber cork.
5. Connect inlet to water tap and leave outlet tune in the sink.
6. Reflux the contents in water bath for 45 minutes.
7. Avoid and take care of no evaporation from water bath and from conical flask.
8. Remove the flask from the water bath.
9. Wash the inner wall of condenser with little water and collect the washings into the flask
10. Add 2-3 drops of phenolphthalein indicator and titrate against 0.5 N HCL.
11. Repeat the same procedure and take at least three readings.

Part 2

1. Take 25 ml of 0.5 N KOH solution in the conical flask.
2. Add 1-2 drops of phenolphthalein indicator and titrate against 0.5 N HCL solution from burette till the pink colored solution becomes colourless.
3. Repeat the above procedure and take three readings.

XII. Resources used (with major specifications)

Sr. No.	Instrument /Components	Specification	Quantity
1			
2			
3			
4			
5			
6			

XIII. Actual procedure followed

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XIV. Precautions followed

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XV. Observations and Calculations

Observations: (BACK)

1. Solution in burette = 0.5 N KOH solution.
2. Solution in conical flask = oil sample mix with 25 ml 0.5 N KOH.
3. Indicator = phenolphthalein.
4. End point = ……

Sr. No.	Pilot Reading		Burette Reading (ml)			Constant Burette Reading Y (ml)
			I	II	III	
Final						
Initial						
Difference						

Observations: (BLANK)

5. Solution in burette = 0.5 N HCL solution.
6. Solution in conical flask = 25 ml 0.5 N KOH
7. Indicator = phenolphthalein
8. End Point = …….

Sr No .	Readings Pilot Reading		Burette Reading (ml)			Constant Burette Reading X (ml)
			I	II	III	
Final						
Initial						
Difference						

Sample Calculation:

1. 25 ml of 0.5 N KOH is added in 5 gram of oil sample. During the processes of saponification part of KOH is consumed to saponify the fatty oils. The unused KOH solution is titrated with 0.5 N HCl solution. Let the reading be ---------- (Y ml)

2 A blank titration of 25 ml of 0.5 N KOH solution is carried out with 0.5 N HCl solution Let the reading be ---------- (X ml)

X-Y =Z = = The amount of KOH consumed to saponify fatty oils in 5 gm of oil sample.

1000 ml of 1 N KOH = 56.119 gram of KOH

1000 ml of 0.5 N KOH =28.059 gram of KOH

1 ml of 0.5 N KOH =28.059 milligram of KOH

Z ml of 0.5 N KOH =28.059* Z milligram of KOH

5gm of oil sample requires 28.059* Z milligram of KOH for saponification

1 gm of oil sample requires = $\frac{28.059*Z \text{ milligram of KOH}}{5}$

1 gm of oil sample requires = $\frac{28.059* \text{ -------- milligram of KOH}}{5}$

1 gm of oil sample requires = ---------- milligrams of KOH

XVI. Results

Saponification value of oil is --------- milligrams of KOH

XVII. Interpretation of result

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XVIII. Conclusions

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XIX. Practical related Questions

Note: *Below given are five sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO*

1. Define saponification
2. Name four lubricating oils.
3. Prepare list of edible and non- edible oils available in the market.
4. Give the importance of saponification value.
5. Give the difference between fatty oil and mineral oil.

[Space for Answers]

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XX. References / Suggestions for further Reading

- https://en.wikipedia.org/wiki/Saponification_value
- https://www.scribd.com
- https://www.classle.net

XXI. Assessment Scheme

Performance indicators		Weightage
Process related (15 Marks)		**60%**
1	Preparation of experimental set up	20%
2	Safety measures	20%
3	Setting and operation	20%
Product related (10 Marks)		**40%**
4.	Interpretation of result & conclusions	10%
5.	Answers to practical related questions	10%
T**otal (25 Marks)**		**100 %**

Names of Student Team Members

1……

2……

3……

4……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.08: Determine Acid value of lubricating oil by KOH titration method.

I. Practical Significance

Acid Number is an indicator of oil serviceability. It is useful in monitoring acid buildup in oils due to depletion of antioxidants. Oil oxidation causes acidic byproducts to form. High acid levels can indicate excessive oil oxidation or depletion of the oil additives and can lead to corrosion of the internal components. By monitoring the acid level, the oil can be changed before any damage occurs. Higher the acid value, more the corrosion of the machine surfaces, more wear and tear, more significance cost for machine.

II. Relevant Program Outcomes (POs)

PO 1. **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.

PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

PO 4. **Engineering tools:** Apply relevant technologies and Chemical engineering tools with an understanding of the limitations.

III. Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency ***'Apply the concept of organic chemistry in chemical engineering applications.***'

1. Perform accurate titration.
2. Follow safety precaution while handling hazardous chemicals

IV. Relevant Course Outcomes

Prepare the soap and detergent using relevant oils

V. Practical Outcome

Determine acid value of lubricating oil by chemical analysis.

VI. Relevant Affective domain related Outcome

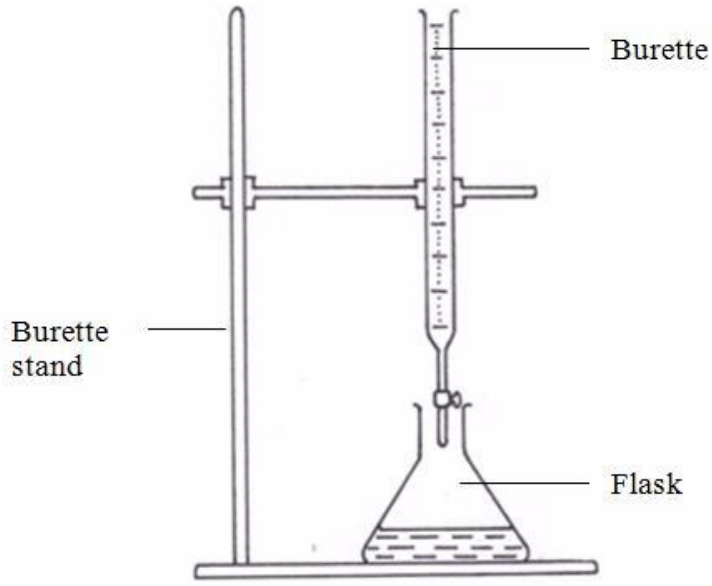
1. Follow safe practices
2. Practice good housekeeping
3. Demonstrate working as leader/ a team member

VII. Minimum Theoretical Background

Acid value of oil:

It is defined as the number of milligrams of KOH required to neutralize free fatty acids present in one gram of oil. The presence of mineral acids in lubricating oil is so rare that it is almost unnecessary to look for it, unless the oil is refined in a fatty manner. Free organic acids or acidic bodies are always found in lubricating oils, whether they be pure mineral oils or compounded oils with fatty oils. In good lubricating oil the acid value should be very low. Increase in acid value should be taken as an indicator of oxidation of the oil which may lead to gum and sludge formation besides corrosion.

VIII. Experimental setup



IX. Resources required

Sr. No.	Instrumentation/components	Specification	Quantity
1	Beaker	100ml	02
2	Conical flask	250ml	01
3	Weighing balance		01
4	Measuring cylinder	50ml	01
5	Burette	25ml	01

X. Precautions to be followed

1. Use apron while doing practical.
2. Use hand gloves while handling concentrate chemicals.

XI. Procedure

Determination of acid value of lubricating oil.

1. Take 1 gm of lubricating oil in conical flask.
2. Add 50 ml of ethanol to oil and shake the solution to dissolve oil completely.
3. Add 2-3 drops of phenolphthalein indicator into the solution in conical flask.
4. Fill the burette with 0.01 N KOH solution.
5. Titrate the solution with 0.01 N KOH solution.
6. Observe the end point colourless to pink of solution.
7. Note the volume of 0.01 N KOH.

8. Repeat step no.1 to 7 for constant burette reading.

XII Resources used (with major specifications)

S. No.	Instrument /Components	Specification	Quantity
1			
2			
3			
4			
5			

XIII. Actual procedure followed

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XIV. Precautions followed

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XV Observations and Calculations

1. Weight of oil taken (w) = ……gm
2. Solution in burette = 0.01 N KOH
3. Solution in conical flask = 1 gm.of oil + 50ml of ethanol
4. Indicator = Phenolphthalein
5. End Point = ……..

Sr. No .	Readings Pilot Reading		Burette Reading (ml)			Constant Burette Reading (ml) X
			I	II	III	
Final						
Initial						
Difference						

Sample Calculation:

1000 ml of 1N KOH = 56.119 gram of KOH
1 ml of 1N KOH = 56.119 milligram of KOH
1 ml of 0.01 N KOH = 56.119* 0.01 milligram of KOH
X ml of 0.01 N KOH = 56.119 * 0.01 *…… milligram of KOH

Acid value of oil sample = 56.119 * 0.01 *……. milligram of KOH /Weight of Oil sample

=

Acid Value = _____.

XVI Results

Acid value of lubricating oil is _____

XVII. Interpretation of result

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XVIII. Conclusions

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XIX. Practical related Questions

Note-Below given are five sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO

1. List out the lubricants oil available in the market
2. Give the significance of acid value of lubricating oil.
3. Classify the types of oil.
4. Why standardization of KOH is done?

[Space for Answers]

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XX. References / Suggestions for further Reading

- htttps://www.classle.net/#!/classle/book/estimation-acid-value-oil
- https://www.youtube.com/watch?v=KZ35K05SA7g
- www.thechemicalengineer.com
- www.chemistry.harvard.edu

XXI. Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of the chemicals and apparatus.	20%
2	Recording of readings	20%
3	Determination of strength	20%
Product related (10 Marks)		**40%**
4	Interpretation of result & conclusions	20%
5	Practical related questions	20%
T**otal (25 Marks)**		**100 %**

Names of Student Team Members

1……

2……

3……

4……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 9: Prepare Soap by batch manufacturing process

I. Practical Significance

Soap is important consumer product used in everyday life. Manufacturing of soap will give the basic hands on experience which will be helpful while working in actual plant. It will be also helpful to understand safety measures required during process.

II. Relevant Program Outcomes (POs)

PO 1. ***Basic knowledge:*** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.

PO 3. *Experiments and practice:* Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III. Competency and Skills

This practical is expected to develop the following skills for the industry identified competency ***'Apply the concept of organic chemistry in chemical engineering applications.***'

1.Perform saponification process in batch process.
2.Follow safety precaution while handling chemicals.

IV. Relevant Course Outcome(s)

Prepare soap and detergent using relevant oil.

V. Practical Outcome

Prepare Soap by batch manufacturing process.

VI. Relevant affective Domain related Outcomes

1. Follow safety precaution
2. Practice good housekeeping
3. Demonstrate working as leader/ a team member
4. Maintain tools and equipment's
5. Follow ethical practices

VII. Minimum Theoretical Background

Saponification is the hydrolysis of fats or oils under basic conditions to afford glycerol and the salt of the corresponding fatty acid. Saponification literally means "soap making". Vegetable oils and animal fats are the traditional materials that are saponified. These greasy materials, tri esters called triglycerides, are mixtures derived from diverse fatty acids. Triglycerides can be converted to soap in either a one- or a two-step process. In the traditional one-step process, the triglyceride is treated with a strong base (e.g., lye), which cleaves the ester bond; releasing fatty acid salts (soaps) and glycerol. This process is also the main industrial method for producing glycerol. In some soap-making, the glycerol is left in the soap. If necessary, soaps may be precipitated by salting it out with sodium chloride.

VIII. Practical Setup

Hot plate

Beaker

Glass rod

IX. Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Beaker	500 ml & 250 ml	1 & 2
2	Hot Plate	Max 500 ^{o}C	1
3	Measuring cylinder	500 ml	1
4	Oil	Any vegetable oil	10 gm
5	Sodium hydroxide		10 gm
6	Ethanol	95%	20 ml
7	Sodium chloride		50 gm

X. Precautions to be Followed

1. Use a properly grounded electrical outlet of correct voltage and current handling capacity for hot plate.
2. Disconnect from power supply while organizing setup.
3. Use all chemicals as per given quantity.
4. Use safety goggles while performing practical.
5. Handle caustic soda carefully.

XI. Procedure

1. Place 10 gm of oil in 500 ml beaker whose saponification value is measured in Practical number 7.
2. Calculate amount of caustic required for completely saponify given oil sample.
3. Add water into caustic to get 25% caustic solution.
4. Add 20 ml of 95% ethanol in caustic solution.
5. Add caustic + ethanol solution in oil beaker.
6. Mix all ingredients carefully and place it on hot plate.
7. Boil the mixture for 30 minutes.
8. Use ethanol water solution to avoid excessive foaming.
9. Make 25% salt solution of 50 gm of salt.
10. Pour soap solution to salt solution.
11. Stir and cool the solution at room temperature.
12. Filter the soap and air dry it.

13. Weigh the final product soap.

XII. Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					
5.					

XIII. Actual Procedure Followed

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XIV. Actual Precautions Followed

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XV. Observations and Calculations

1. Weight of the soap formed = _____ gms.
2. Appearance of soap formed is _____in colour.

XVI. Results

Yield of soap from given quantity of oil is =

XVII. Interpretation of Results (Giving meaning to the results)

XVIII. Conclusions (Actions to be taken based on the interpretations.)

XIX. Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such Questions so as to ensure the achievement of identified CO.

1. Write specifications of hot plate used in practical.
2. Write the ways to make soap colourful.
3. Write name of the companies who are manufacturing soap in India.
4. List the name of oils used for manufacturing of soap.

[Space for Answers]

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XX. References / Suggestions for Further Reading

1. http://ethesis.nitrkl.ac.in/5371/1/109CH0476.pdf
2. http://www.madehow.com/Volume-2/Soap.html
3. http://nptel.ac.in/courses/103107082/module4/lecture1/lecture1.pdf
4. https://www.youtube.com/watch?v=lQ6fCZgYc8g
5. https://www.youtube.com/watch?v=_5rSdmsMtog

XXI. Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks))		**60%**
1	Handling of apparatus/setup	20%
2	Recording of reading	20%
3	Safety measures followed	20%
Product Related (10 Marks))		**40%**
4	Interpretation of result & Conclusion	20%
5	Practical related questions	20%
Total (25 Marks)		100 %

Names of Student Team Members

1…….

2……

3……

4……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 10: Determine moisture content of soap

I. Practical Significance

One of the most important aspects of creating high quality soap flakes is optimizing moisture content. If moisture is not kept at the right levels during the production process, the product quality becomes inferior, which leads to waste and losses in profits.

II Relevant Program Outcomes (POs)

PO 1. **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III. Competency and Skills

This practical is expected to develop the following skills for the industry identified competency ***'Apply the concept of organic chemistry in chemical engineering applications.***'

- Use oven to determine moisture content in soap.
- Operate oven and use of electronic balance.

IV. Relevant Course Outcome(s)

Prepare soap and detergent using relevant oil.

V. Practical Outcome

Determine moisture content of soap.

VI. Relevant affective Domain related Outcomes

1. Follow safety precaution
2. Practice good housekeeping
3. Demonstrate working as leader/ a team member

VII. Minimum Theoretical Background

Moisture content is a parameter that is used in assessing the shelf life of a product. High moisture content in soap would lead to reaction of excess water with un-saponified fat to give free fatty acid and glycerol in a process called hydrolysis of soap on storage. From the values obtained in the analysis quality of soap can be determined.

VIII. Practical Setup

Oven

Electronic balance

porcelain dish

IX . Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Oven	Upto 300 ^{o}C, with temp controller	1No.
2	Weighing balance	1-20 gm	1 No.
3	Soap sample	Toilet soap	10 gm
4	Porcelain dish	100 ml	2 No.

X. Precautions to be Followed

1 Use a properly grounded electrical outlet of correct voltage and current handling capacity for electric oven.
2 Disconnect from power supply while organizing setup.
3 Set given temperature in the oven. Do not over heat.
4 Use safety goggles while performing practical.

XI. Procedure

1. Weigh the dried porcelain dish which will be used for practical (W_1).
2. Measure 10 gm of sliced soap sample and place in dish.
3. Weigh the porcelain dish with soap (W_2)
4. Heat the dish with sample in oven for 2 hours at 110^{o}C.
5. Cool the dish in desiccator and take weight (W_3)

XII. Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					

XIII. Actual Procedure Followed

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XIV. Actual Precautions Followed

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XV. Observations and Calculations

1. Weight of dry porcelain dish, W_1 = gm
2. Weight of porcelain dish + Soap, W_2 = gm
3. Weight of porcelain dish + Soap, after drying , W_3 = gm

% moisture = $(W_3 – W_1) / (W_3 – W_2)$ X 100

% moisture =

XVI. Results

Moisture content in given soap sample =

XVII. Interpretation of Results

Moisture content in soap in is **above/within/below** the range given in Encyclopedia of Industrial Chemical Analysis. (10-15%)

XVIII. Conclusions

Quality of given soap is _____.

[Space for Answers]

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XIX. Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Write maximum temperature setting possible in oven.
2. Write specification of soap written on its cover.
3. Observe the change in soap after heating and record it.
4. Write the types of toilet soaps available in the market.

[Space for Answers]

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XX. References / Suggestions for Further Reading

1. http://www.chinoamerica.com/application/im/pdf/APP-022_soap.pdf
2. https://www.arcjournals.org/pdfs/ijarcs/v3-i6/2.pdf
3. https://file.scirp.org/pdf/OJAppS_2014071113371731.pdf
4. https://www.solverchem.com/articles/category/properties-of-soap-and-detergent-detergent-encyclopedia/details
5. file:///C:/Users/student/Downloads/ChemPhyCharacteristicsofSoapMadefrmDistilled FattyAcidsofPalmOilandPKO-1.pdf

XXI. Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks))		**60%**
1	Handling of apparatus/setup	20%
2	Recording of reading	20%
3	Safety measures followed	20%
Product Related (10 Marks))		**40%**
4	Interpretation of result & Conclusion	20%
5	Practical related questions	20%
Total (25 Marks)		**100 %**

Names of Student Team Members

1 …….

2 …….

3 …….

4 …….

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 11: Determine hiding power of paint

I. Practical Significance

Hiding power is the ability to hide the surface of an object. When applied too thin, a coating lacks sufficient hiding power. The hiding power of paint measures its ability to obscure a background of contrasting color. Hiding power is also known as opacity and contrast ratio. Opacity is a film property, whereas hiding power is a property of the whole paint. Hiding is a more general term used frequently to refer to either opacity or hiding power. The hiding power is directly linked to the film application method and the film thickness.

II. Relevant Program Outcomes (POs)

PO 1. **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.

PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III. Competency and Skills

This practical is expected to develop the following skills for the industry identified competency ***'Apply the concept of organic chemistry in chemical engineering applications.***'

1. Application of paint on surface evenly.
2. Follow safety precaution while handling paint.

IV. Relevant Course Outcome(s)

1. Use hiding power principle for manufacturing of paint, varnishes and lacquers.

V. Practical Outcome

1. Determine hiding power of paint

VI. Relevant affective Domain related Outcomes

1. Practice good housekeeping
2. Demonstrate working as leader/ a team member
3. Follow ethical practices

VII. Minimum Theoretical Background

White pigments scatter incident visible light at all wavelengths while colored pigments absorb incident visible light at characteristic wavelengths, a good dispersion of pigments in the binder media strongly influences the hiding power of a coating.

In a coating with strong hiding power, the pigment particles scatter the light so strongly that it hardly reaches the substrate. If residual light is reflected from the substrate, it is so strongly scattered that it does not reach the eye. For a coating to scatter the light optimally, an even, fine distribution of the pigment stabilized by dispersing additives is essential.

Low hiding power in a coating can be caused by:

1. Inefficient deagglomeration
2. Pigment flocculation

The main characteristics that influence hiding power are:

1. High refractive index
2. Optimized particle size

There are a number of test methods available, but the most familiar is the use of hiding power charts to measure hiding power of paints. These are colored cards to which paint is applied and an assessment is made of the extent to which the color pattern is obliterated.

VIII. Practical Setup

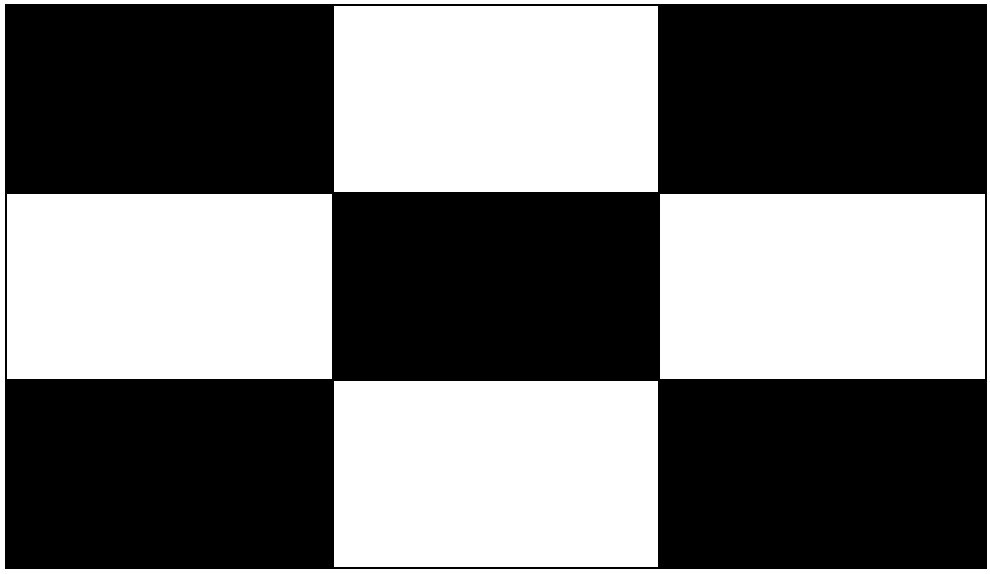

Chart Pattern for hiding power of paint

IX. Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Paint	Oil paint	100 gm
2	Glass plate	1' X 1'	1 No
3	Chart Pattern for hidingpower of paint	1' X 1'	1 No
4	Brush	25 mm	1 No
5	Weighing balance	Max capacity 500 gm	1 No

X. Precautions to be Followed

1. Do not keep oil container open for longer time.
2. Shake container thoroughly for proper mixing of colour

XI. Procedure

1. Weigh the paint container and brush (W_1)
2. Stick hiding power chart on the surface of glass in such a way that it can be seen from other side.
3. Apply paint in small increments on glass surface on the other side until the difference between black and white back ground disappears.
4. Measure the hidden surface of glass.
5. Weigh the paint container and brush (W_2) after applying colour.

XII. Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					
5.					

XIII. Actual Procedure Followed

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XIV. Actual Precautions Followed

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XV. Observations and Calculations

1. Weight of the paint container and brush (W_1) = …….. gm
2. Weight of the paint container and brush after applying colour (W_2) = …….....gm
3. Hiding surface area of glass = ……cm^2

Hiding power of paint = Hidden surface area of glass (cm^2) / Paint used (gm)

Hiding power of paint =

XVI. Results

Hiding power of given paint sample is =

XVII. Interpretation of Results

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XVIII. Conclusions (Actions to be taken based on the interpretations.)

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XIX. Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Name the pigment used in paint applied on glass plate.
2. Write unit operation used in manufacturing of paint.
3. Write name of the companies who are manufacturing paint in India.
4. Name the material used for manufacturing of brush.

[Space for Answers]

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XX. References / Suggestions for Further Reading

1. www.corrosionpedia.com/definition/631/hiding-power-hp
2. https://www.eboss.co.nz/detailed/heather-goode/blocking
3. http://www.resene.co.nz/archspec/cpd_earn_points/pdfs/CPD_volumesolidspvchiding _ oct2003.pdf
4. https://www.astm.org/Standards/D344.htm
5. https://gardnerlaboratories.com/2014/06/25/display-drawdown-charts-spreading-rate-drawdown-charts-explained/

XXI. Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks))		**60%**
1	Handling of apparatus/setup	20%
2	Recording of reading	20%
3	Safety measures followed	20%
Product Related (10 Marks))		**40%**
4	Interpretation of result & Conclusion	20%
5	Practical related questions	20%
Total (25 Marks)		**100 %**

Names of Student Team Members

1 …….

2……

3……

4……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 12: Determine % of thinner in given sample of oil paint

I. Practical Significance

Thinners are defined as chemical compounds that are introduced into the paint prior to application, in order to modify the viscosity and other properties related to the rate of curing that may affect the functionality and aesthetics of the final layer painting. By knowing thinner content in paint its application can be decided.

II. Relevant Program Outcomes (POs)

PO 1. **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III. Competency and Skills

This practical is expected to develop the following skills for the industry identified competency ***'Apply the concept of organic chemistry in chemical engineering applications.***'

1. Use of air oven for drying paint.
2. Follow safety precaution while handling paint.

IV. Relevant Course Outcome(s)

Prepare Use hiding power principle for manufacturing of paint, varnishes and lacquers.

V. Practical Outcome

Determine % of thinner in given sample of oil paint

VI. Relevant affective Domain related Outcomes

1. Follow safety precaution
2. Practice good housekeeping
3. Demonstrate working as leader/ a team member

VII. Minimum Theoretical Background

Solvent (sometimes called a thinner) - either an organic solvent or water is used to reduce the viscosity of the paint for better application. Water-borne paints are replacing some paints that use volatile organic compounds such as the hydrocarbons which are harmful to the atmosphere. In paints, solvents dissolve or disperse different components used in the paint formulation (such as pigment and resin), making paint the desired consistency for application. Once paint is applied, the solvent evaporates, allowing resin and pigment to produce a film of paint (a coat) and dry rapidly. The use of solvents in paints provides a variety of effective choices among durable and decorative coatings and glossy paints for indoor and outdoor uses.

VIII. Practical Setup

Metal Dish

Hot air oven

IX. Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Paint	Oil paint	1 gm
2	Metal Dish	8 cm	1 No
3	Hot air oven	Max temperature 250^{o}C	1 No
4	Weighing balance	Max capacity 500 gm	1 No

X. Precautions to be Followed

1. Use a properly grounded electrical outlet of correct voltage and current handling capacity for oven.
2. Do not exceed the temperature mentioned in procedure.
3. Use safety goggle and hand gloves.
4. Do not keen any ignition source near oven to avoid contact with solvent vapors.

XI. Procedure

1. Weigh the metal dish (W_1).
2. Take 10 gm of paint in dish and take weight of both (W_2)
3. Place the dish in oven.
4. Heat the paint at 110^{o}C in oven for 3 hrs.
5. Cool the dish after heating and take weight (W_3).
6. Calculate thinner content.

XII. Resources Used

S. No	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					

2.					
3.					
4.					
5.					

XIII. Actual Procedure Followed

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XIV. Actual Precautions Followed

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XV. Observations and Calculations

1. Weight of the metal dish (W_1) = …….. gm
2. Weight of the dish and paint (W_2) = …….gm
3. Weight of paint sample (Y) = ……..gm
4. Weight of the dish and paint after heating (W_3) = …….gm

   Thinner content in given paint sample (Z) = $W_2 - W_3$ = ……gm

   % of thinner content = (Z / Y) X 100

   =

XVI. Results

Thinner content in the given oil paint is =

XVII. Interpretation of Results

XVIII. Conclusions (Actions to be taken based on the interpretations.)

XIX. Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Write specifications of hot air oven.
2. List the thinners used in paint.
3. Write name of the MOC of dish used for drying.
4. Write the time required to attend sent point of oven.

[Space for Answers]

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XX. References / Suggestions for Further Reading

1 https://nvlpubs.nist.gov/nistpubs/nbstechnologic/nbstechnologicpaperT76.pdf
2 http://msdssearch.dow.com/PublishedLiteratureDOWCOM/dh_0943/0901b803809484.pdf?filepath=coatings/pdfs/noreg/884-00545.pdf&fromPage=GetDoc
3 http://www.essentialchemicalindustry.org/materials-and-applications/paints.html
4 http://simulatedlab.in/Laboratory/chemistry/oil-paint/oil-paint.php

XXI. Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks))		**60%**
1	Handling of apparatus/setup	20%
2	Recording of reading	20%
3	Safety measures followed	20%
Product Related (10 Marks))		**40%**
4	Interpretation of result & Conclusion	20%
5	Practical related questions	20%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. …….
2. …….
3. …….
4. …….

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 13: Prepare Phenol Formaldehyde resin on laboratory scale

I. Practical Significance

Phenol formaldehyde resins (PF) or phenolic resins are synthetic polymers obtained by the reaction of phenol or substituted phenol with formaldehyde. PF were the first commercial synthetic resins (plastics). PF resin is used as the basis for Bakelite manufacturing, Electrical Parts, Automotive Applications, Electrical/Electronic Applications, Coating Applications and High Temperature Applications.

II. Relevant Program Outcomes (POs)

PO 1. **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III. Competency and Skills

This practical is expected to develop the following skills for the industry identified competency ***'Apply the concept of organic chemistry in chemical engineering applications.***'

1. Preparation of phenolic resin
2. Follow safety precaution while handling various chemicals.

IV. Relevant Course Outcome(s)

Use polymerization process for preparation of various polymers.

V. Practical Outcome

Prepare Phenol Formaldehyde resin on laboratory scale

VI. Relevant affective Domain related Outcomes

1. Follow safety precaution
2. Practice good housekeeping
3. Demonstrate working as leader/ a team member

VII. Minimum Theoretical Background

The formation of phenol formaldehyde follows step – growth polymerization. The process can be either acid – catalyzed or base – catalyzed. Base-catalyzed phenol formaldehyde resins are made with formaldehyde to phenol ratio of around 1.5. Such resins are sometimes called resols, and are found in varied industrial products. Laminates are made by impregnating one or more layers of base materials like paper or cotton with phenolic resin with the application of temperature and pressure. Moreover the resins act as binding agents in brake pads, brake shoes and various other applications.

The polymerization process for the manufacture of phenol formaldehyde is an exothermic one and is controlled by a batch reactor as the viscosity of the material changes rapidly.

The raw materials for the process – phenol, formaldehyde and the catalyst are mixed in a jacketed autoclave, which is also termed as a resin kettle. Inside the autoclave, the mixture is heated with steam. Water cooling and refluxing remove the excess heat of reaction. During the initial stages of the reaction, the heavy viscous resins settle as the bottom layer, with an aqueous layer on top. A combination of heat and vacuum in the resin kettle (autoclave) enables the dehydration of the reaction mixture.

At around 130-150°C, the resin fuses and is removed from the kettle. Then product is then cooled and is ground to form fine powders. This molding powder which forms can be mixed with fillers, coloring agents, lubricants and catalysts in a ball mill. In order to prepare the commercial phenolic molding powder, the final product may be further heated on a pair of differential heating rolls.

VIII. Practical Setup

Beaker

Glass rod

IX. Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Phenol		1 m
2	Glacial acetic acid		1 ml
3	Formadehyde	40 % aq. solution	2.5 ml
4	HCl	Concentrated	10 ml
5	Filter paper		2 No.
6	Glass rod		1 No
7	Weighing balance	1 to 100 gm	1 No

X. Precautions to be Followed

1. Handle beaker containing phenol carefully.
2. Handle concentered hydrochloric acid safely.
3. Use safety goggle and hand gloves.
4. Do not keen any ignition source near oven to avoid contact with solvent vapors.

XI. Procedure

1. Place 5 ml glacial acetic acid and 2.5 ml of 40 % aq. formaldehyde solution in beaker.
2. Add 2 gm of phenol safely in it.
3. Place beaker in water bath to remove heat.
4. Add concentered HCl drop wise with vigorous stirring by glass rod till pink colored gummy mass appeared.
5. Allow the reaction to complete for 20 minutes.
6. Wash pink colored mass several times till removal of free acid.

7. Filter the product and dry it in oven.
8. Weigh the polymer produced.

XII. Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					
5.					

XIII. Actual Procedure Followed

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XIV. Actual Precautions Followed

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XV. Observations and Calculations

1. Weight of polymer before drying = …… gm
2. Weight of polymer after drying = ……gm

XVI. Results

Weight of dry polymer = …….. gm

XVII. Interpretation of Results

XVIII. Conclusions (Actions to be taken based on the interpretations.)

XIX. Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Note colors of raw material used in process.
2. Count the number of washing cycles used to make polymer acid free.
3. Note the final color of polymer.
4. Write % concentration of hydrochloric acid mentioned on bottle.

[Space for Answers]

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XX. References / Suggestions for Further Reading

1 https://www.youtube.com/watch?v=1SH_8GpLZy4
2 http://www.brcmcet.edu.in/downloads/files/n535b8b2307022.pdf
3 http://www.jo-mo.com/wctmgurgaon/data/chemistry.pdf
4 http://www.polymerjournals.com/pdfdownload/1222005.pdf
5 http://nptel.ac.in/courses/103103029/40

XXI. Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks))		**60%**
1	Handling of apparatus/setup	20%
2	Recording of reading	20%
3	Safety measures followed	20%
Product Related (10 Marks))		**40%**
4	Interpretation of result & Conclusion	20%
5	Practical related questions	20%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……
2. …….
3. ……
4. …….

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 14: Determine acid value of given sample of polymer

I. Practical Significance

The determination of the acid value plays an important part in the analysis of raw materials for plastics. The acid value corresponds to the amount of carboxylic acid groups in alkyl resins, polyester acrylate resins or mixtures and is given in mg KOH per g sample. It is also used in evaluating plasticizers, in which acid values should be as low as possible.

II. Relevant Program Outcomes (POs)

PO 1. **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III. Competency and Skills

This practical is expected to develop the following skills for the industry identified competency ***'Apply the concept of organic chemistry in chemical engineering applications.***'

1.Preparation of polymer sample for titration.
2.Follow safety precaution while handling flammable solvent.

IV. Relevant Course Outcome(s)

1. Use polymerization process for preparation of various polymers.

V. Practical Outcome

1. Determine acid value of given sample of polymer

VI. Relevant affective Domain related Outcomes

1. Follow safety precaution
2. Practice good housekeeping
3. Demonstrate working as leader/ a team member
4. Follow ethical practices

VII. Minimum Theoretical Background

Acid value (or neutralization number or acid number or acidity) is the mass of potassium hydroxide (KOH) in milligrams that is required to neutralize one gram of chemical substance. The acid number is a measure of the number of carboxylic acid groups in a chemical compound, such as a fatty acid, or in a mixture of compounds. In a typical procedure, a known amount of sample dissolved in an organic solvent (often isopropanol) and titrated with a solution of potassium hydroxide (KOH) of known concentration using phenolphthalein as a color indicator.

The acid number is used to quantify the acidity of a substance e.g. biodiesel. It is the quantity of base, expressed in milligrams of potassium hydroxide that is required to neutralize the acidic constituents in 1 g of sample.

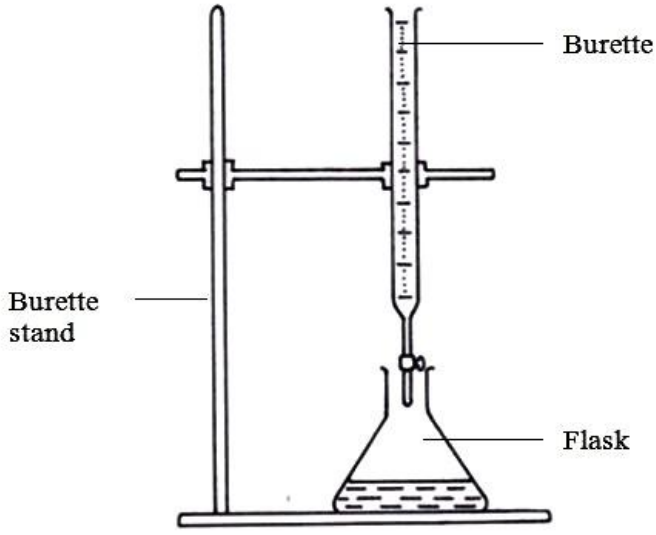
The determination of the acid value plays an important part in the analysis of raw materials for plastics. The acid value corresponds to the amount of carboxylic acid groups in alkyl resins, polyester acrylate resins or mixtures and is given in mg KOH per g sample. It is also used in evaluating plasticizers, in which acid values should be as low as possible.

$$AV = \frac{\text{ml of KOH x N x 56}}{\text{Weight of Sample}} = \text{mg of KOH}$$

AV = Acid value

N = Normality of KOH

VIII. Practical Setup



IX. Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Polymer sample	Plastic, resin	1 gm
2	Conical Flask	250 ml	1 No
3	Burette	25 ml	1 No
4	Ethanol	Anhydrated	75 ml
5	Potassium hydroxide	0.01 N	1000 ml

X. Precautions to be Followed

1. Handle ethanol carefully. Avoid contact with skin and eyes.
2. Warm the solution carefully. Excess heat may cause bumping of solution.
3. Wear safety goggles.

XI. Procedure

1. Weigh accurately 1 gm of given plastic sample
2. Transfer it to dry 250 ml conical flask
3. Add 75 ml ethanol into flask
4. Warm the solution in the flask using water bath until plastic dissolve into ethanol
5. Fill the burette with 0.01 N KOH solution.
6. Cool the solution and add Phenolphthalein indicator
7. Titrate it with 0.01 N KOH solution placed in burette till solution turns pink.

XII. Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					
5.					

XIII. Actual Procedure Followed

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XIV. Actual Precautions Followed

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XV. Observations and Calculations

1. Weight of sample = …….. gm
2. Solution in burette = 0.01 N KOH solution
3. Solution in conical flask = Ethanol + sample
4. Indicator = Phenolphthalein
5. End point =……

Readings	Pilot reading	Burette reading (ml)			Constant burette reading (ml)
		I	II	III	
Initial					
Final					
Difference					

$$AV = \frac{\text{ml of KOH x N x 56}}{\text{Weight of Sample}} = \text{mg of KOH}$$

XVI. Results

Acid value of given polymer sample = ……. mg of KOH/gm of sample

XVII. Interpretation of Results

XVIII. Conclusions (Actions to be taken based on the interpretations.)

XIX. Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Write the details of sample taken for analysis.
2. Write the precautions for handling ethanol mentioned on bottle.
3. Explain the importance for rinsing of burette.
4. Write ignition temperature of ethanol.

[Space for Answers]

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XX. References / Suggestions for Further Reading

1. http://www.nkpatel.co.in/Practical%20charts/Polymer.pdf
2. https://www.ias.ac.in/article/fulltext/boms/036/02/0277-0286
   http://www.european-coatings.com/Forum/Testing-measuring/HOW-TO-MEASURE-DETERMINE-ACID-VALUE-OF-UNSATURATED-POLYESTER-RESIN-COMPLETE-DETAILS
3. http://shodhganga.inflibnet.ac.in/bitstream/10603/9891/9/09_chapter%203.pdf
4. http://simulatedlab.in/Laboratory/chemistry/acid-value-of-plastic-material/acid-value-of-plastic-material-performance.php

XXI. Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**60%**
1	Handling of apparatus/setup	20%
2	Recording of reading	20%
3	Safety measures followed	20%
Product Related (10 Marks)		**40%**
4	Interpretation of result & Conclusion	20%
5	Practical related questions	20%
	Total (25 Marks)	**100 %**

Names of Student Team Members

1 …….

2 ……..

3 ……..

4 …….

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 15: Determine acid value of given sample of phenol

I. Practical Significance

The determination of the acid value plays an important part in the analysis of raw materials for resin. The acid value corresponds to the amount of carboxylic acid groups in alkyl resins, polyester acrylate resins or mixtures and is given in mg KOH per g sample. It is also used in evaluating plasticizers, in which acid values should be as low as possible.

II. Relevant Program Outcomes (POs)

PO 1. **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency ***'Apply the concept of organic chemistry in chemical engineering applications.***'

1. Preparation of phenol sample for titration.
2. Follow safety precaution while handling phenol.

IV. Relevant Course Outcome(s)

1. Use polymerization process for preparation of various polymers.

V. Practical Outcome

1. Determine acid value of given sample of phenol

VI. Relevant affective Domain related Outcomes

1. Follow safety precaution
2. Practice good housekeeping
3. Demonstrate working as leader/ a team member
4. Follow ethical practices

VII. Minimum Theoretical Background

Acid value (or neutralization number or acid number or acidity) is the mass of potassium hydroxide (KOH) in milligrams that is required to neutralize one gram of chemical substance. The acid number is a measure of the number of carboxylic acid groups in a chemical compound, such as a fatty acid, or in a mixture of compounds. In a typical procedure, a known amount of sample dissolved in an organic solvent (often isopropanol) and titrated with a solution of potassium hydroxide (KOH) of known concentration using phenolphthalein as a color indicator.

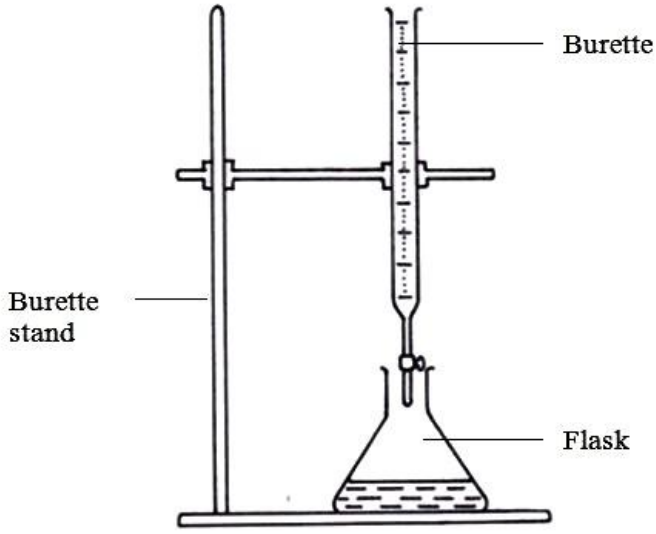
The acid number is used to quantify the acidity of a substance e.g. biodiesel. It is the quantity constituents in 1 g of sample. The determination of the acid value plays an important part in the analysis of raw materials for plastics. The acid value corresponds to the amount of carboxylic acid groups in alkyl resins, polyester acrylate resins or mixtures and is given in mg KOH per g sample. It is also used in evaluating plasticizers, in which acid values should be as low as possible.

$$AV = \frac{\text{ml of KOH x N x 56}}{\text{Weight of Sample}} = \text{mg of KOH}$$

AV = Acid value

N = Normality of KOH

VIII. Practical Setup



IX. Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Phenol		1 gm
2	Conical Flask	250 ml	1 No
3	Burette	25 ml	1 No
4	Ethanol	Anhydrous	75 ml
5	Potassium hydroxide	0.01 N	1000 ml

X. Precautions to be Followed

1. Handle ethanol and phenol carefully. Avoid contact with skin and eyes.
2. Do not heat phenol, it will explode above 85^{o}C.
3. Wear safety goggles.

XI. Procedure

1. Weigh accurately 1 gm of phenol sample
2. Transfer it to dry 250 ml conical flask
3. Add 75 ml anhydrous ethanol into flask
4. Dissolve phenol into ethanol
5. Fill the burette with 0.01 N KOH solution.
6. Cool the solution and add Phenolphthalein indicator

7. Titrate it with 0.01 N KOH solution placed in burette till solution turns pink .

XII. Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					
5.					

XIII. Actual Procedure Followed

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XIV. Actual Precautions Followed

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XV. Observations and Calculations

1. Weight of sample = …….. gm
2. Solution in burette = 0.01 N KOH solution
3. Solution in conical flask = Ethanol + sample
4. Indicator = Phenolphthalein
5. End point =……

Readings	Pilot reading	Burette reading (ml)			Constant burette reading (ml)
		I	II	III	
Initial					
Final					
Difference					

$$AV = \frac{\text{ml of KOH x N x 56}}{\text{Weight of Sample}} = \text{mg of KOH}$$

XVI. Results

Acid value of given sample of phenol = ……. mg of KOH/gm of sample

XVII. Interpretation of Results

XVIII. Conclusions (Actions to be taken based on the interpretations.)

XIX. Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Write properties of phenol.
2. Write the precautions for handling phenol (as mentioned on container).
3. Explain the importance for rinsing of burette.

[Space for Answers]

XX. References / Suggestions for Further Reading

1. www.chemguide.co.uk/organicprops/phenol/acidity.html
2. http://cpcb.nic.in/uploads/News_Letter_Phenols_Phenolic_Compounds_2017.pdf
3. http://jnec.org/lab-manuals/fe/ec_es_lab_manual.pdf
4. https://pubchem.ncbi.nlm.nih.gov/compound/phenol#section=Top

XXI. Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**60%**
1	Handling of apparatus/setup	20%
2	Recording of reading	20%
3	Safety measures followed	20%
Product Related (10 Marks)		**40%**
4	Interpretation of result & Conclusion	20%
5	Practical related questions	20%
Total (25 Marks)		**100 %**

Names of Student Team Members

1 …….

2 ……

3 ……

4 ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 16: Perform decolorization of paper by bleaching

I. Practical Significance

Bleaching is important technic to get whiteness to paper. Bleaching is required for removing color from pulp during production process of paper pulp. During deinking process of recycled paper beaching is required. Hydrogen peroxide and sodium dithionite are used to increase the brightness of deinked pulp. The bleaching methods are similar for mechanical pulp in which the goal is to make the fibers brighter.

II Relevant Program Outcomes (POs)

PO 1. **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency ***'Apply the concept of organic chemistry in chemical engineering applications.***'

1.Preparation testing setup for paper bleaching.
2.Follow safety precaution while handling sodium hypochlorite and hydrogen peroxide.

IV. Relevant Course Outcome(s)

1. Prepare pulp and paper using sulfite and sulphate process.

V. Practical Outcome

1. Perform decolorization of paper by bleaching

VI. Relevant affective Domain related Outcomes

1. Follow safety precaution
2. Practice good housekeeping
3. Demonstrate working as leader/ a team member

VII. Minimum Theoretical Background

Pulp and paper industry is one of the largest consumers of bleaching chemicals. The principal objective in bleaching any type of pulp is usually to increase the whiteness of the pulp, as measured by its brightness, which is defined as reflectance measured at a wavelength of 457 nm. Virtually all of the color of any pulp resides in its lignin component. Because concurrent cellulose damage would seriously weaken the fibers, pulping is therefore terminated when 5-8% of the original lignin remains. Bleaching effluent is typically contaminated with chloride ion and chlorine compounds, making it difficult or impossible to recycle it to the recovery system because of potential for corrosion. It is therefore necessary to treat and discharge the bleaching effluent.

Brightness is the amount of incident light reflected from paper under specified conditions, usually reported as the percentage of light reflected, so a higher number means a brighter or whiter paper. the processes and fundamental chemistry involved in bleaching chemical pulps (like kraft or sulfite) are very different from those involved in bleaching mechanical pulps (like stoneground, thermomechanical or chemithermomechanical). Chemical pulps contain very little lignin while mechanical pulps contain most of the lignin that was present in the wood used to make the pulp.

Lignin is the main source of color in pulp due to the presence of a variety of chromophores naturally present in the wood or created in the pulp mill.

VIII. Practical Setup

Set of beakers

IX. Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Sodium hypochlorite	Industrial grade	100 ml
2	Hydrogen peroxide	35% industrial grade	100 ml
3	Beaker	100 ml	10 no
4	Color paper	A4 size sheet of any color	2 no

X. Precautions to be Followed

1. Handle sodium hypochlorite and hydrogen peroxide carefully .
2. Avoid contact with skin and eyes.
3. Wear hand gloves.
4. Wear safety goggles.

XI. Procedure

1. Make ten strips of colored paper.
2. Arrange ten empty beakers for bleaching solution
3. Prepare 5 samples of sodium hypochlorite solution of 5%, 10%, 15%.20% and 25%.
4. Prepare 5 samples of hydrogen peroxide solution of 5%, 10%, 15%.20% and 25%.
5. Insert one strip each in all ten beakers.
6. Observe the change in color of paper strip and note down reading in table.

XII. Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					

XIII. Actual Procedure Followed

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XIV. Actual Precautions Followed

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XV. Observations and Calculations

Beaker no	Concentration of bleach solution (%)	Observation of change in color	Time required to bleach
Sodium hypochlorite			
1			
2			
3			
4			
5			
Hydrogen peroxide			

6			
7			
8			
9			
10			

XVI. Results

Strong belching solution for given paper strip in less time = ……% concentration

XVII. Interpretation of Results

XVIII. Conclusions (Actions to be taken based on the interpretations.)

XIX. Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Note color of hypochlorite and peroxide solution.
2. Write the precautions for handling sodium hypochlorite mentioned on bottle.
3. Write the effect of bleaching solution on white paper.
4. Use different color papers and observe the change in color.

[Space for Answers]

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XX. References / Suggestions for Further Reading

1. http://textilefashionstudy.com/textile-bleaching-process-definition-objectives-process-parameters-of-bleaching/
2. https://www.youtube.com/watch?v=1pXc5yx0H8o
3. https://en.wikipedia.org/wiki/Bleaching_of_wood_pulp
4. http://nptel.ac.in/courses/103107082/module3/lecture2/lecture2.pdf
5. http://www.pulppapermill.com/chlorine-dioxide-bleaching/
6. http://155.187.2.69/epbc/notices/assessments/2007/3385/pubs/17effluent.pdf
7. https://onlinelibrary.wiley.com/doi/10.1002/0471238961.1621121613030415.a01

XXI. Assessment scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**60%**
1	Handling of apparatus/setup	20%
2	Recording of reading	20%
3	Safety measures followed	20%
Product Related (10 MArks)		**40%**
4	Interpretation of result & Conclusion	20%
5	Practical related questions	20%
Total (25 Marks)		100 %

Names of Student Team Members

1 ……

2 ……

3 ……

4 …….

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

List Of Laboratory Manuals Developed by MSBTE

First Semester:

1	Fundamentals of ICT	22001
2	English	22101
3	English Work Book	22101W
4	Basic Science (Chemistry)	22102
5	Basic Science (Physics)	22102

Second Semester:

1	Bussiness Communication Using Computers	22009
2	Computer Peripherals & Hardware Maintenace	22013
3	Web Page Design with HTML	22014
4	Applied Science (Chemistry)	22202
5	Applied Science (Physics)	22202
6	Applied Machines	22203
7	Basic Surveying	22205
8	Applied Science (Chemistry)	22211
9	Applied Science (Physics)	22211
10	Fundamental of Electrical Engineering	22212
11	Elements of Electronics Engineering	22213
12	Elements of Electrical Engineering	22215
13	Basic Electronics	22216
14	C Language programming	22218
15	Basic Electronics	22225
16	Programming in C	22226
17	Fundamental of Chemical Engineering	22231

Third Semester:

1	Applied Multimedia Techniques	22024
2	Advanced Serveying	22301
3	Highway Engineering	22302
4	Mechanics of Structures	22303
5	Building Construction	22304
6	Concrete Technology	22305
7	Strength Of Materials	22306
8	Automobile Engines	22308
9	Automobile Transmission System	22309
10	Mechanical Operations	22313
11	Technology Of Inorganic Chemicals	22314
12	Object Oriented Programming Using C++	22316
13	Data Structure Using 'C'	22317
14	Computer Graphics	22318
15	Database Management System	22319
16	Digital Techniques	22320
17	Principles Of Database	22321
18	Digital Techniques & Microprocessor	22323
19	Electrical Circuits	22324
20	Electrical & Electronic Measurment	22325
21	Fundamental Of Power Electronics	22326
22	Electrical Materials & Wiring Practice	22328
23	Applied Electronics	22329
24	Electrical Circuits & Networks	22330
25	Electronic Measurments & Instrumentation	22333
26	Principles Of Electronics Communication	22334
27	Thermal Engineering	22337
28	Engineering Matrology	22342
29	Mechanical Engineering Materials	22343
30	Theory Of Machines	22344

Fourth Semester:

1	Hydraulics	22401
2	Geo Technical Engineering	22404
3	Chemical Process Instrumentation & Control	22407
4	Fluid Flow Operation	22409
5	Technology Of Organic Chemical	22410
6	Java Programming	22412
7	GUI Application Development Using VB.net	22034
8	Microprocessor	22415
9	Database Managment	22416
10	Electric Motors And Transformers	22418
11	Industrial Measurement	22420
12	Digital Electronic And Microcontroller Application	22421
13	Linear Integrated Circuits	22423
14	Microcontroller & Applications	22426
15	Basic Power Electronics	22427
16	Digital Communication Systems	22428
17	Mechanical Engineering Measurments	22443
18	Fluid Mechanics and Machinery	22445
19	Fundamentals Of Mechatronics	22048
20	Micro Project & Industrial Training Assessment Manual	22049

Fifth Semester:

1	Network Management & Administration	17061
2	Solid Modeling	17063
3	CNC Machines	17064
4	Behavioral Science(Hand Book)	17075
5	Behavioral Science (Assignment Book)	17075
6	Windows Programming using VC++	17076
7	Estimation and Costing	17501
8	Public Health Engineering	17503
9	Concrete Technology	17504
10	Design of Steel Structures	17505
11	Switchgear and Protection	17508
12	Microprocessor & Application	17509
13	A.C. Machines	17511
14	Operating System	17512
15	Java Programming	17515
16	System Programming	17517
17	Communication Technology	17519
18	Hydraulic & Pneumatics	17522
19	Advanced Automobile Engines	17523
20	Basic Electrical & Electronics	17524
21	Measurement and Control	17528
22	Power Engineering	17529
23	Metrology & Quality Control	17530
24	Computer Hardware & Networking	17533
25	Microcontroller	17534
26	Digital Communication	17535
27	Control System & PLC	17536
28	Audio Video Engineering	17537
29	Control System	17538
30	Industrial Electronics and applications	17541
31	Heat Transfer Operations	17560
32	Chemical Process Instrumentation & control	17561

Sixth Semester:

1	Solid Modeling	17063
2	Highway Engineering	17602
3	Contracts & Accounts	17603
4	Design of R.C.C. Structures	17604
5	Industrial Fluid Power	17608
6	Design of Machine Elements	17610
7	Automotive Electrical and Electronic Systems	17617
8	Vehicle Systems Maintenance	17618
9	Software Testing	17624
10	Advanced Java Programming	17625
11	Mobile Computing	17632
12	System Programing	17634
13	Testing & Maintenance of Electrical Equipments	17637
14	Power Electronics	17638
15	Illumination Engineering	17639
16	Power System Operation & Control	17643
17	Environmental Technology	17646
18	Mass Transfer Operation	17648
19	Advanced Communication System	17656
20	Mobile Communication	17657
21	Embedded System	17658
22	Process Control System	17663
23	Industrial Automation	17664
24	Industrial Drives	17667
25	Video Engineering	17668
26	Optical Fiber & Mobile Communication	17669
27	Therapeutic Equipment	17671
28	Intensive Care Equipment	17672
29	Medical Imaging Equipment	17673

Pharmacy Lab Manual

First Year:

1	Pharmaceutics - I	0805
2	Pharmaceutical Chemistry - I	0806
3	Pharmacognosy	0807
4	Biochemistry and Clinical Pathology	0808
5	Human Anatomy and Physiology	0809

Second Year:

1	Pharmaceutics - II	0811
2	Pharmaceutical Chemistry - II	0812
3	Pharmacology & Toxicology	0813
4	Hospital and Clinical Pharmacy	0816

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